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CHARLES H. LOWE, M. INST. C.E.,
PAST PRESIDENT.

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PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXVII. 1900-1901

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(Secretary of the Association)

The Association is not as a body responsible for the facts and opinions advanced herein.

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CONTENTS.

The Incorporated Association of Municipal and County Engineers.

LIST OF OFFICERS, 1901–1902.

COUNCIL.

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1885–6. *R. VAWSER, M. INST. C.E.	1899–00. W. HARPUR, M. INST. C.E.
1886–7. J. LOBLEY, M. INST. C.E.	1900–01. C. H. LOWE, M. INST. C.E.

* Deceased.

Vice-Presidents.

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A. CREER, ASSOC. M. INST. C.E., CITY SURVEYOR, YORK.
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C. F. WIKE, M. INST. C.E., CITY SURVEYOR, SHEFFIELD.

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Secretary.

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Telegraphic Address: "BISECTING, LONDON."

Telephone Number: "588 WESTMINSTER."

LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

* *Those Members against whose names a star is placed have obtained the Certificate of the Association.*

R *signifies re-election under Bye-law 5a.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1897 Oct. 16	BECHMANN, G.	Ingénieur en chef des Ponts et Chaussées, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CAREY, MAJOR-GENERAL C. PHIPPS	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1901 Mar. 23	HASSELT, J. VAN	Director of Public Works, Amsterdam.
1886 June 12	MANSERGH, JAS., M. Inst. C.E.	5 Victoria Street, Westminster, S.W.
1892 Apr. 23	PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, HY., M. Inst. C.E.	13 Victoria St., Westminster, S.W.
1888 Mar. 3	TAYLOR, ARNOLD, C.E.	Local Government Board, Whitehall, S.W.
1874 June 1	TULLOCH, MAJOR H., R.E.	Local Government Board, Whitehall, S.W.

MEMBERS.

1898 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21	ABURROW, C., M. Inst. C.E...	Town Engineer, Johannesburg, S.A.
1893 Jan. 14	ADSHEAD, E. E.	Borough Surveyor, Macclesfield.
1896 Jan. 18	AITKEN, T., A.M. Inst. C.E.	County Surveyor, Cupar, Fife.
1897 Jan. 16	ALLEN, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2	ALLEN, T. T...	Broad Street, Stratford-on-Avon.
1897 June 19	ALVES, G.	Surveyor to the Urban District Council, Glastonbury.
1890 June 26	ANDERSON, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
1900 Dec. 15	ANDERSON, W. V...	City Surveyor, Winchester.
1898 June 30 / T1899 Oct. 21	*ANDREWS, S. P.	Surveyor to the Urban District Council, Caversham

Date of Election and Transfer.		
1894 Oct. 20 T1899 Oct. 21	*ANGEL, R. J.	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*ANGELL, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1873 Feb. 15 R1899 Oct. 21	ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer.*)	"Calside," Carlisle Road, Eastbourne.
1899 June 29	ANSTER, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	ARMISTEAD, R., Assoc. M. Inst. C.E.	115 Main Street, Bingley, Yorkshire.
1893 July 31	ARMYTAGE, W. K. L.	Borough Surveyor, Yeovil.
1900 June 16	ASQUITH, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	ATKINSON, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1895 June 27 T1896 June 25	*ATKINSON, W.	Surveyor, Epworth, near Doncaster.
1897 Feb. 13	BAFF, C. J.	Surveyor to the Urban District Council, Gosforth, Newcastle-on-Tyne.
1900 Feb. 10	BAINS, G.	Surveyor to the Urban District Council, Saltburn-by-the-Sea.
1884 May 29	BAKER, F.	Borough Surveyor, Middlesbrough, Yorks.
1891 Aug. 1	BAKER, J., A.M. Inst. C.E. ..	Surveyor, Slough.
1896 June 25	BALDWIN, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
1891 Aug. 1 T1896 Feb. 22	*BALL, B., A.M. Inst. C.E. ..	Borough Surveyor, Nelson, Lancs.
1898 Dec. 17	BALL, F...	Borough Surveyor, Southwold, Suffolk.
1887 Sept. 17 T1898 Feb. 19	*BALL, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1879 Oct. 23	BANKS, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1887 Mar. 12	BARBER, J. Patten, M. Inst. C.E. (*Vice President.*)	Borough Surveyor, Islington, N.
1888 Sept. 15 T1892 July 11	*BARNES, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1890 May 3	BARRAS, C. C.	Surveyor to the Rural District Council, Doncaster.
1890 Feb. 1	BARRATT, F. W.	Borough Surveyor, Bethnal Green, N.E.
1897 Jan. 16	BARRETT, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1899 Jan. 21	BARRS, J. D.	Surveyor to the Urban District Council, Bromyard.
1898 Jan. 15	BARTON, J. L..	Surveyor to the Urban District Council, St. Helens, Isle of Wight.
1896 Oct. 24	BAYLIS, T. P., A. M. Inst. C.E.	Borough Surveyor, Droitwich.
1891 Sept. 12	BEATSON, W.	Borough Surveyor, Leith.
1894 Jan. 13	BEAUMONT, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.

Date of Election and Transfer.		
1897 Mar. 13	Beaumont, G. E.	Surveyor to the Rural District Council, Wortley. "Holme Lea," Greenoside, near Sheffield.
1897 Mar. 13	Beaumont, T. C.	Surveyor to the Rural District Council, Driffield.
1896 Nov. 28	Bell, A. W., A. M. Inst. C.E.	City Engineer, Dunfermline.
1892 Jan. 16	Bell, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
1897 Jan. 16	Bell, G. J., Assoc. M. Inst. C.E.	County Surveyor, Cumberland.
1895 Jan. 19	Bellingham, A. W. H., Assoc. M. Inst. C.E.	Municipal Engineer, Tientsin, China.
1896 Jan. 18	Bennett, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1888 Dec. 18	Bennett, W. B. G., Assoc. M. Inst. C.E.	Borough Surveyor, Southampton.
1898 Dec. 17 T1900 July 19	*Bennetts, J. P.	Surveyor to the Urban District Council, Harrow.
1886 Oct. 16	Berrington, R. E. W., Assoc. M. Inst. C.E.	Graisley, Wolverhampton.
1892 Mar. 11 R1899 May 6	Beswick, W. H., Assoc. M. Inst. C.E.	Moss Side, Exmouth.
1891 June 6	Bettany, F.	Borough Engineer, Burslem.
1896 Nov. 28	Biker, T.	Surveyor to the Urban District Council, Whitworth, Facit, near Rochdale.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	Chief Engineer, London County Council, Spring Gardens, S.W.
1896 Nov. 28	Bird, W. F.	Surveyor to the Urban District Council, Midsomer Norton.
1897 Jan. 16	Birks, E.	Highway Surveyor to Rural District Council, Uxbridge.
1891 June 25	Bishop, McW.	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1901 Feb. 16	Blackburn, J.	Surveyor to the Urban District Council, Soothill Upper.
1873 Feb. 15	Blackshaw, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
1886 June 12	Blair, W. N., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, St. Pancras.
1900 Mar. 10	Blood, A. T.	Surveyor to the Urban District Council, St. Neots, Hunts.
1895 Oct. 19	Boden, E. G.	Surveyor to the Rural District Council, Romford.
1895 Jan. 19	Botterill, C., A.M.Inst.C.E.	Borough Surveyor, Fulham. Town Hall, Walham Green, S.W.
1878 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	44 Campden House Court, Kensington, W.
1898 Mar. 19	Bowen, H. W.	District Surveyor, Hayward's Heath.
1880 Oct. 2	Bower, J.	Borough Engineer, Gateshead-on-Tyne.
1898 Feb. 19	Bowles, A. R., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sandgate.
1898 Oct. 15	Boyle, J. C.	City Surveyor, Armagh.
1894 Oct. 20	Bradford, J. H.	Surveyor to the Urban District Council, Aylesbury.

Date of Election and Transfer.		
1889 May 18 T1893 Apr. 22	*Bradley, J. W., Assoc. M. Inst. C.E.	City Engineer, Westminster, S.W.
1897 Jan. 16	Bradley, W. L.	Surveyor to the Urban District Council, Tonbridge.
1894 Jan. 13 1896 Oct. 24	*Bradshaw, F. E. G.	Surveyor to the Urban District Council, Trowbridge.
1873 May 2	Bressey, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Mar. 21	Bretland, J. C., M. Inst. C.E.	City Surveyor, Belfast.
1891 Aug. 1	Brett, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	Brettell, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	Bridges, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	Brierley, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	Brodie, J. A., M. Inst. C.E.	City Engineer, Liverpool.
1889 Apr. 13	Brodie, J. S., A.M. Inst. C.E.	Borough Engineer, Blackpool.
1894 Oct. 20	Brooke, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1885 Feb. 7 R1892 Apr. 23	Brooke, W., Assoc. M. Inst. C.E.	Surveyor to the R.D.C., Strood. "Lympstone," Goddington Road, Strood.
1891 Feb. 21	Broom, G. J. C., M.Inst. C.E.	Borough Engineer, St. Helen's, Lancashire.
1884 July 10	Brown, A., M. Inst. C.E.	Borough Engineer, Nottingham.
1897 May 15	Brown, Chas.	Burgh Surveyor, Hawick, N.B.
1898 Jan. 15	Brown, C.	Surveyor to the Urban District Council, Bedlingtonshire.
1881 Jun. 18	Brown, J. W., Assoc. M.Inst. C.E.	Borough Engineer, West Hartlepool.
1894 July 7 T1898 Sept. 3	*Brown, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 R1898 Jan. 15	*Brown, R. R.	Electrical Engineer to the Urban District Council, Bridlington.
1893 June 24	Brown, W. I.	Borough Surveyor, Northampton.
1893 Mar. 4	*Brownridge, C., Assoc. M. Inst. C.E.	Borough Engineer, Birkenhead.
1901 Feb. 16	Bryce, J.	Burgh Surveyor, Partick, N.B.
1873 May 2	Buckham, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8	Buckley, M. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Drumcondra.
1897 Feb. 13	Bull, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
1895 Feb. 16	Bunting, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	Burden, A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	Burgess, S. E., M. Inst. C.E.	Borough Engineer, South Shields.
1900 Apr. 21	Burkitt, J. P.	County Surveyor, Fermanagh.
1900 July 19	Burnet, C. D.	Electrical Engineer, Carlisle.
1890 June 7	Burslam, R.	Borough Surveyor, Congleton.
1877 Nov. 9	Burton, J. H.	150A Stamford Street, Ashton-under-Lyne.
1897 Jan. 16	Busbridge, T. A.	Surveyor to the Rural District Council, Spilsby.

Date of Election and Transfer.		
1890 Sept. 13	Butler, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	Butterworth, A. S.	Borough Surveyor, Hythe.
1885 Dec. 18	Button, F. S., M. Inst. C.E.	Consulting Borough Surveyor, Burnley. Blannel Street, Burnley.
1894 Apr. 6	Caine, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12	Cairncross, T. W., Assoc. M. Inst. C.E.	11 Colonnade Buildings, Green Market Square, Cape Town, S.A.
1895 July 27	Calvert, W.	Surveyor to the Urban District Council, Hebden Bridge.
1894 June 21	Cameron, D.	City Surveyor, Exeter.
1891 Oct. 17	Campbell, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Ham, E.
1887 Mar. 12	Campbell, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
1888 May 12	Capon, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 M1899 Jan. 21	Card, H.	North Street, Lewes.
1891 June 25	Carline, J., A. M. Inst. C.E.	District Surveyor, Lewisham. Catford Hill, S.E.
1901 June 27	Carter, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19	Carter, G. F., Assoc. M. Inst.. C.E.	Surveyor to the Urban District Council, Mexborough.
1898 Dec. 17	Cartwright, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1900 May 19	Cartwright, F.	Municipal Engineer, Howrah, Bengal.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	Peel Chambers, Market Place, Bury.
1895 Mar. 16	Cass, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
1895 Mar. 16 M1899 Feb. 25	Catt, A. J.	"Laurel Dene," Kingstone-by-Sea, near Brighton.
1896 Mar. 21	Chadwick, J...	Surveyor to the Urban District Council, Fenny Stratford.
1901 Dec. 7	Chancellor, W. B.	Surveyor to the Urban District Council, Brownhills, Staffs.
1897 Jan. 16	Chapman, C. R. W.	Surveyor to the Urban District Council, Wembley.
1893 Mar. 4 M1899 May 6	Charles, T.	Peterborough Road, Harrow.
1884 Dec. 20	Chart, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1900 Feb. 10	Chowins, W. H.	Surveyor to the Urban District Council, Lynton.
1884 Oct. 9	Clare, J., A.M. Inst. C.E...	Surveyor to the Urban District Council, Sleaford.
1898 Sept. 3	Clark, E. O'N.	County Surveyor, Leitrim.
1899 Oct. 21	Clarke, H. A.	Surveyor to the Urban District Council, Briton Ferry.

Date of Election and Transfer.		
1898 Oct. 15	Clarry, W. H.	Borough Surveyor, Sutton Coldfield.
1899 Dec. 16	Clarson, A. S.	Surveyor to the Urban District Council, Filey.
1886 Dec. 18	Clarson, H. J.	Borough Surveyor, Tamworth.
1901 May 11	Clayton, F. T.	Borough Engineer, Reigate.
1893 July 31	Clough, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	Clucas, R. H.	Borough Surveyor, Kendal.
1894 July 7 T1896 Oct. 24	*Coales, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
1886 Oct. 16 T1888 July 12	*Coales, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	Cockrill, J. W., M. Inst. C.E. *(Member of Council.)*	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern District.
1893 June 24	Cockrill, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1892 Sept. 24	Collen, W. M.A., M.Inst.C.E.	County Surveyor, Dublin. 9 Hume Street, Dublin.
1897 July 31	Collingwood, T. A.	Surveyor to the Urban District Council, Itchen, Woolston, Southampton.
1888 May 12	Collins, A. E., M. Inst. C.E. *(Member of Council.)*	City Engineer, Norwich.
1900 Oct. 15	Collins, G. M.	Town Hall, Withington, Manchester.
1896 Jan. 18	Collins, R.	Surveyor to the Urban District Council, Enfield, N.
1886 May 1 R1897 Feb. 13	Comber, P. F., M. Inst. C.E.	Town Surveyor, Bray. 19 Lower Leeson Street, Dublin.
1897 July 31 T1900 Dec. 15	*Cook, F. C.	Surveyor to the Urban District Council, Hinckley.
1893 Apr. 22	Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
1888 July 12 T1890 Mar. 29	*Cook, J., Assoc. M. Inst. C.E. *(Member of Council.)*	Borough Surveyor, Lancaster; *Hon. Secretary*, Lancashire and Cheshire District.
1894 Mar. 3	Cooke, E.	Surveyor to the Urban District Council, Abersychan, Pontypool.
1888 July 12 T1890 Mar. 29	*Cooper, C. H., M. Inst. C.E.	Surveyor to the Urban District Council, Wimbledon, S.W.
1898 Sept. 3	Cooper, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	Cooper, F. A., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	Cooper, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22	Copley, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Nov. 28	Corbett, J.	Borough Engineer, Salford.
1896 Jan. 18	Cordon, R. C.	Surveyor to the Rural District Council, Belper. Hazelwood, Derby.

Date of Election and Transfer.		
1896 May 29 T1897 Jun. 19	*Corrie, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 Jun. 21	Cotterell, A. P. I., Assoc. M. Inst. C.E.	Surveyor, Rural District Council, Barton Regis. 28 Baldwin Street, Bristol.
1891 Jun. 25 R1897 July 31	Coverley, J. S.	Surveyor, Penmaenmawr.
1891 Oct. 17 R1899 May 6	Cowan, P. C., M. Inst. C.E.	33 Ailesbury Road, Dublin.
1898 May 21	Cox, J.	Surveyor to the Urban District Council, Margam, Port Talbot.
1880 Feb. 7	Cox, J. H., M. Inst. C.E.	City Surveyor, Bradford.
1900 Mar. 10	Crabtree, W.	Highway Surveyor to the Rural District Council, Doncaster.
1887 Dec. 10	Crabtree, W. H. B., Assoc. M. Inst. C.E.	Borough Surveyor, Doncaster.
1881 May 6	Creer, A., Assoc. M. Inst. C.E. (*Member of Council.*)	City Surveyor, York.
1900 July 19	Cross, A. W.	Surveyor to the Urban District Council, King's Norton.
1889 Dec. 14	*Crowther, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Bootle.
1900 Jun. 16	Cumming, W.	Highway Surveyor to the Rural District Council, Lanchester, co. Durham.
1889 Dec. 14	Currall, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	Curry, W. F.	Surveyor to the Urban District Council, Morpeth. Barkis, Valley R.S.O., Aylesbury.
1893 Mar. 4 R1899 Feb. 25	Curry, W. T., A. M. Inst. C.E.	"Beverley," Stroud Road, Gloucester.
1897 Feb. 13	Cutler, H. A., A. M. Inst. C.E.	City Surveyor, Cork.
1893 Jun. 24	*Dalton, J. P. .. .. .. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne; *Hon. Secretary*, Northern District.
1899 Jan. 21	Davidson, J. F.	Surveyor to the Urban District Council, Willington Quay.
1900 Oct. 15	Davies, W. J.	Borough Surveyor, Pwllheli.
1880 Apr. 10	Davis, A. T., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Salop.
1900 Oct. 15	Dawson, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19	Dawson, C. J.	Surveyor, Barking.
1896 July 25	Dawson, N. H.	Borough Surveyor, Banbury.
1879 May 1	Dawson, W., M. Inst. C.E.	Surveyor to the Urban District Council, Leyton, N.E..
1898 Jan. 15	Day, C.	Borough Surveyor, Chatham.
1873 Dec. 9	DEACON, G. F., M. Inst. C.E. (*Past President.*)	16 Great George Street, Westminster, S.W.
1898 Jan. 15	Deane, J.	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*Dearden, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.

Date of Election and Transfer.		
1895 Oct. 19	DEBNAM, A. W.	Surveyor to the Urban District Council, East Stonehouse, Devon.
1890 Feb. 1	DENNIS, N. F., A.M.Inst.C.E.	Surveyor to the Urban District Council, Aldershot.
1880 May 27	DENT, W.	Railway Street, Nelson, Lancashire.
1890 Sept. 13	DEVERELL, T. C., Assoc. M. Inst. C.E.	City Engineer, Calcutta.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
1898 Oct. 15 T1899 Jun. 10	*DICKINSON, A. J.	Surveyor to the Rural District Council, Long Crendon, Thame, Oxon.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1890 Sept. 13 R1896 Jan. 18	DICKINSON, T. R., Assoc. M. Inst. C.E.	17 Clifton, York.
1900 Feb. 10	DIGGLE, J.	Surveyor to the Urban District Council, Matlock.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1889 Sept. 21	DIGGLE, WM.	Surveyor, Frodsham, Chester.
1877 Oct. 20	DITCHAM, H.	Borough Surveyor, Harwich.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Desborough.
1897 Jan. 16	DIXON, F. J., A.M. Inst. C.E.	Prospect Crescent, Harrogate.
1891 Aug. 1 T1896 Oct. 24	*DIXON, J. R., A.M. Inst. C.E.	Borough Surveyor, Shoreditch, N.E.
1887 June 18	DIXON, R., Assoc.M.Inst.C.E.	Borough Surveyor, Stratford-on-Avon.
1889 July 4	DODD, P., Assoc. M. Inst.C.E.	Borough Surveyor, Western District, Wandsworth, S.W.
1897 Jan. 16	*DODGEON, A.	Surveyor to the Urban District Council, Clayton-le-Moors.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
1899 Oct. 21	DRYLAND, A.	County Surveyor, Hereford.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15	DUNCH, T. H.	59 Darnley Road, Gravesend.
1899 Oct. 21	DUNKLEY, C.	Borough Surveyor, Higham Ferrers.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	32 Victoria Street, Westminster, S.W.
1891 Jan. 21 T1892 Sept. 24	*DYACK, W., M. Inst. C.E.	Burgh Surveyor, Aberdeen.
1882 June 29	DYER, S...	Surveyor, Bridlington.
1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1900 May 19	EASTWOOD, J.	Town Hall, Halifax.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.

Date of Election and Transfer.		
1877 Nov. 18	EAYRS, J. T., M. Inst. C.E. (*Past President.*)	89 Corporation Street, Birmingham.
1890 May 3	EBBETTS, D. J.	Surveyor to the Urban District Council, Acton.
1893 Mar. 4	ECKERSLEY, W.	Surveyor to the Urban District Council, Chadderton, Lancashire.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.
1891 Jan. 21 R1896 Jan. 18	*EDGE, F. J., A. M. Inst. C.E.	City Engineer's Office, Liverpool.
1888 May 12	EDINGER, P.	Surveyor to the Urban District Council, Frome.
1891 Sept. 12	EDMONDSON, S.	Surveyor to the Rural District Council, Burnley.
1896 Jan. 18	EDSON, W.	City Surveyor, Ripon.
1899 Mar. 25	EDWARDS, J. V.	County Surveyor, West Riding, Yorkshire. Wakefield.
1898 Apr. 23	EDWARDS, T. L.	County Surveyor, Glamorgan. Bridgend, Glam.
1897 July 31	*ELFORD, E. J.	Surveyor to the Urban District Council, Portland.
1885 Oct. 8	ELFORD, J.	Borough Surveyor, Poole.
1873 Feb. 15 R1890 May 3	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	34 Victoria Street, Westminster, S.W.
1900 Apr. 21	ELLIOTT, F. T.	Surveyor to the Rural District Council, Isle of Thanet. Birchington-on-Sea.
1893 Oct. 21 R1901 Feb. 16	ELLIS, R. E., M. Inst. C.E. ..	70–72 Chancery Lane, W.C.
1895 July 27	ENTWISLE, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
1873 May 2 R1900 Apr. 10	ESCOTT, E. R. S., M. Inst. C.E. (*Past President.*)	16 Clifton Road, Halifax.
1896 June 25	EVANS, A. J. L.	Borough Surveyor, Luton.
1897 Jan. 16	EVANS, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	EVANS, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, South Wales.
1896 May 29	EVANS, J. P.	Surveyor to the Rural District Council, Wrexham.
1890 June 7	FAIRLEY, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W.
1898 June 30 T1899 Feb. 25	*FARNHAM, W. A.	Surveyor to the Urban District Council, Milton, next Sittingbourne.
1887 July 14	FARRALL, T.	Surveyor to Urban District Council, Sherborne, Dorset.
1893 July 31	FARRINGTON, T. B.	Borough Engineer, Conway.
1896 Jan. 18	FARRINGTON, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1896 Nov. 28	FEATHER, F.	Surveyor to the Urban District Council, Chepstow.
1896 Jan. 18	FELKIN, H. R.	Surveyor, Southall Norwood.

Date of Election and Transfer.		
1900 Dec. 15	Fellows, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	Fenn, T...	Surveyor to the Urban District Council, Belper.
1887 Sept. 17 R1899 June 10	Fiddian, W.	Surveyor, Old Bank Offices, Stourbridge.
1899 Jan. 21	Fidler, A.	Borough Engineer, Southend-on-Sea.
1894 Jan. 13	Findlay, R., A.M. Inst. C.E.	Surveyor to the Parish of Eltham, Eltham Green, S.E.
1892 May 28 T1897 Jan. 16	*Fitton, G.	Borough Surveyor, Basingstoke.
1895 Oct. 19	Fleming, M. J.	Borough Surveyor, Town Hall, Waterford.
1893 Jan. 14 R1899 May 6	Flower, T. J. M., Assoc. M. Inst. C.E.	Scottish Buildings, Baldwin Street, Bristol, and 28 Victoria Street, Westminster, S.W.
1895 July 27 T1899 Jan. 21	*Forbes, A. H.	Surveyor to the Urban District Council, Saffron Walden.
1896 Nov. 28	Ford, G...	City Surveyor, St. Albans.
1888 July 12	Forder, W. G., A.M. Inst. C.E.	Surveyor to the Board of Works, Lee, S.E.
1897 Jan. 16	Forrester, R.	Surveyor to the Rural District Council, Basingstoke.
1890 Sept. 13	Foster, T.	Surveyor to the Urban District Council, Hoylake and West Kirby.
1900 June 16	Fothergill, J. E.	Surveyor to the Urban District Council, Brentwood.
1873 May 2 R1883 Feb. 17	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester; and 35 Old Queen Street, Westminster, S.W.
1897 Mar. 13	Fox-Allin, C. J.	Surveyor to the Urban District Council, Smethwick.
1888 May 12 T1893 Oct. 21 R1898 Jan. 15	*Franks, T. W., Assoc. M. Inst. C.E.	Seveirg Buildings, Lewes.
1890 Feb. 1	Fraser, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Llandaff, Cardiff. 17 Queen's Chambers, Cardiff.
1893 Oct. 19	Frost, H.	Surveyor to the Urban District Council, Gosport and Alverstoke, Gosport.
1887 June 18 R1898 Jan. 15	Fry, W. H., A.M. Inst. C.E.	9 High Street, Gosport.
1877 Oct. 20	Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road, S.E.
1885 June 6	Gammage, J.	Borough Surveyor, Dudley.
1885 June 27	Gammell, H. H.	Surveyor to the Urban District Council, Perry Barr, near Birmingham.
1881 Dec. 12 R1886 June [illegible]	Garratt, C. T.	Estate Office, Newtown Linford, Leicestershire.
1894 Mar. 3	Garrett, J. H.	County Surveyor, Worcester.
1886 Mar. 13	Gaskell, P.	Surveyor to the Urban District Council, Hornsea, near Hull.

Date of Election and Transfer.		
1886 Dec. 13	Geen, H.	Borough Surveyor, Okehampton.
1901 Oct. 19	Gibbs, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	Gibson, S.	Surveyor to the Urban District Council, Biddulph.
1889 Dec. 14	Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge. 70 Quarry Hill, Tonbridge.
1899 June 10	Gladwell, A.	Highway Surveyor, Rural District Council, Eton. 1 Wrexham Road, Slough, Bucks.
1893 May 13	*Gloyne, R.M., Assoc. M. Inst. C.E.	Borough Surveyor, Eastbourne.
1891 May 2	Godfrey, B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Rotherham.
1883 Feb. 17	Godfrey, R., Assoc. M. Inst. C.E.	"Kilburn," Easingwold, Yorks.
1895 Jan. 19	Golder, T. C.	Borough Surveyor, Deal.
1873 Nov. 8	Goldsworth, W.	Surveyor to the Urban District Council, Prescot, Lancashire.
1899 June 10	Gondie, A. H.	Borough Engineer, Stirling.
1886 June 12	Goodyear, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
1897 June 19	Gordon, F.	Surveyor to the Rural District Council, Halifax, Clifton, Brighouse.
1901 Dec. 7	Gordon, J. C.	Borough Surveyor, Aldeburgh, Suffolk.
1895 Mar. 16	Gow, W. C.	Vestry Surveyor, Vestry Hall, Plumstead.
1897 Oct. 16	Graham, G. A.	Surveyor to the Urban District Council, Witney.
1897 June 19 T1901 Dec. 7	*Grant, F. T...	Borough Surveyor, Gravesend.
1887 Feb. 5 T1893 Apr. 22	*Greatorex, A.D., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, West Bromwich.
1895 Mar. 5	Green, A. A.	Borough Surveyor, Brackley.
1899 June 10	Green, G.	Borough Engineer, Wolverhampton.
1901 Feb. 16	Green, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	Green, W.	Surveyor to the Urban District Council, Castleford.
1890 May 3 E1898 Apr. 23	Greenwell, A., Assoc. M. Inst. C.E.	9 Victoria Street, Westminster, S.W.
1883 May 5	Greenwood, A.	39 Calder Street, Todmorden.
1898 Mar. 19	Gregory, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	Gregson, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	Gregson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1882 Sept. 30	Grieves, R.	Surveyor to the Urban District Council, Cowpen, Blyth, Northumberland.
1897 June 19	Grieves, W. H.	Surveyor to the Urban District Council, Buxton.
1892 Mar. 11	Griffith, F., M. Inst. C.E.	Corporation Waterworks Engineer, Leicester.

Date of Election and Transfer.		
1886 Sept. 11	GRIMLEY, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
1899 Dec. 16	GRIMSHAW, F. H.	Surveyor to the Urban District Council, Atherton.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1892 Apr. 28	GUNNIS, J. W.	County Surveyor, Longford, Ireland.
1890 Mar. 29	GUNYON, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Wood Green, N.
1891 Dec. 12	HACKETT, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
1885 June 6	HAIGH, J., A.M. Inst. C.E. ..	Borough Surveyor, Abergavenny.
1896 Apr. 25	HAINSWORTH, M.	Surveyor to the Urban District Council, Teddington.
1897 June 19	HAGUE, S.	Surveyor to the Urban District Council, Dukinfield.
1899 Dec. 16 T1901 Oct. 19	*HALL, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1884 Apr. 19	HALL, J., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Cheltenham; *Hon. Secretary*, Western District.
1886 May 1	HALL, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Great Crosby.
1900 June 16	HALLAM, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	HALLER, J. C.	Surveyor to the Urban District Council, Guiseley.
1894 July 7	HAMAR, A.	Borough Surveyor, Bishop's Castle, Shropshire.
1887 Mar. 12	HAMBY, G. H., A.M. Inst. C.E.	Borough Engineer, Lowestoft.
1897 Feb. 13	HAMP, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, New Swindon.
1897 Mar. 13	HANSON, J. H.	Surveyor to the Urban District Council, Cottingham, Yorks.
1890 Sept. 13	HANSON, W.	Surveyor to the Rural District Council, Wantage.
1896 Jan. 18	HARA, R.	Engineer to Tokio Fu, Japan.
1873 May 2	HARDING, J. R., M. Inst. C.E.	Surveyor, Epsom, Surrey.
1896 Nov. 28 T1899 Jun. 10	*HARDING, W. D.	Surveyor to the Urban District Council, Exmouth.
1899 Jun. 29	*HARGREAVES, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
1896 Oct. 24	HARLOCK, H., A.M. Inst. C.E.	3 Clifton Terrace, Southend-on-Sea.
1899 May 6	HARMAN, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	HARPUR, A. O.	Surveyor to the Urban District Council, Caerphilly.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President.*)	Borough Engineer, Cardiff.
1896 Jan. 18	HARRIS, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.

Date of Election and Transfer.		
1899 Oct. 21	Harris, T.	Surveyor to the Urban District Council, Portmadoc.
1901 May 11	Harrison, A.	Borough Engineer, Southwark, S.E.
1899 Jun. 29	Harrison, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
1896 Nov. 28	Harston, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Dartford.
1896 Oct. 24	Hartley, T. H.	Borough Surveyor, Colne.
1887 Jun. 18	Harty, S., M. Inst. C.E. I. ..	City Engineer, Dublin.
1889 Dec. 14	Harvey, E. J.	Surveyor to the Urban District Council, Ventnor.
1893 Oct. 21	Harvey, T. F., Assoc. M. Inst. C E.	Engineer to the Urban District Council, Merthyr Tydvil.
1893 July 31	Hawkings, S. T.	Surveyor to the Urban District Council, Bromley.
1892 Apr. 23	Hawley, G. W.	Surveyor to the Rural District Council, Basford. York Chambers, King Street, Nottingham.
1896 Jan. 18	Haycroft, J. L., A. M. Inst. C.E.	Borough Engineer, Woollahra, Sydney.
1895 Apr. 20	Haynes, R. H.	Borough Engineer, Newport, Mon.
1897 June 19 / T1898 Jan. 15	*Hayward, T. W. A.	Borough Surveyor, Sudbury, Suffolk.
1890 May 3	Heath, G. A...	"The Hollies," Malden Road, Watford.
1899 June 10	Heath, J.	Surveyor to the Urban District Council, Urmston.
1885 June 6	Heaton, G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Councils, Abram and Pemberton. King Street, Wigan.
1899 Mar. 25	Helé, J. S.	Surveyor to the Urban District Council, Spalding.
1890 Feb. 1	Henderson, A. J., Assoc. M. Inst. C.E.	Surveyor to the District Highway Board, Kingston-on-Thames.
1895 Jun. 27 / T1901 Oct. 19	*Hendry, J. S.	Surveyor to the Urban District Council, Cannock, Staffs.
1897 Feb. 13	Henry, T.	Surveyor to the Rural District Council, East Retford.
1892 June 11	Heron, J., B.E., B.A.	County Surveyor, Co. Down, Ireland.
1899 May 6	Heslop, T. H. B.	County Surveyor, Norfolk C. C. Norwich.
1875 Dec. 21	Hewson, T., M. Inst. C.E. ..	City Engineer, Leeds.
1894 July 7	Higgens, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	Higgins, J.	Chief Engineer, Grey Co., New Zealand.
1898 Dec. 17	Hinchcliffe, D.	Surveyor to the Urban District Council, Northallerton.
1893 July 13	Hind, H.	Surveyor to the Urban District Council, Erith.
1898 Sept. 3	Hirst, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1895 June 27	Hodgson, W...	Surveyor to the Urban District Council, Keswick.

Date of Election and Transfer.		
1873 Feb. 15 / T1885 Dec. 19	HODSON, G., M. Inst. C.E. ..	Loughborough. Abbey Buildings, Prince's Street, Westminster, S.W.
1896 Apr. 25	*HOGBIN, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
1890 Feb. 1	HOLDEN, J., A.M. Inst. C.E.	Highway Surveyor to the Rural District Council, Llandaff. Ely, Cardiff.
1897 Jan. 16	HOLE, W. P.	Borough Surveyor, Montgomery. Crowther's Hall, Welshpool.
1891 Aug. 1	HOLLINGS, G.	Surveyor to the Urban District Council, Wallsend.
1892 Mar. 11	HOLMES, G. W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Walthamstow, N.E.
1890 June 7	HOLT, G. F.	48 Cecil Road, Upton Manor, E.
1901 Dec. 7	HOLT, W.	Surveyor to the Urban District Council, Sale, Cheshire.
1884 Oct. 9	HOOLEY, COSMO C., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-upon-Irwell, Green Lane, Patricroft.
1884 Oct. 9	HOOLEY, E. P., A.M.Inst.C.E. (*Member of Council.*)	County Surveyor, Nottingham.
1890 May 3	HOPE, W. H.	Surveyor to the Rural District Council, Kingston-on-Thames.
1898 Jan. 15	HOPKINSON, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 40 Bridge Street, Worksop.
1889 Sept. 21	HOPKINSON, W. H., A.M.Inst. C.E.	Borough Engineer, Keighley.
1891 Dec. 12	HORAN, J., M.E., M.Inst.C.E.	County Surveyor, 50 George Street, Limerick, Ireland.
1895 July 27	HORSFALL, W. H. D.	Surveyor to the Urban District Council, Southowram. 9 Harrison Road, Halifax.
1900 May 19	HORSFIELD, J. NIXON	Surveyor to the Urban District Council, Hampton Wick. Kingston-on-Thames.
1890 May 3	HORTON, G. S.	Surveyor to the Urban District Council, Felixstowe.
1894 Mar. 3	HOWARD, H.	Surveyor to the Urban District Council, Littlehampton.
1898 Sept. 3	HOWARD, S.	Surveyor to the Urban District Council, Bradford-on-Avon.
1880 May 27	HOWCROFT, J.	Surveyor to the Urban District Council, Redcar, Yorkshire.
1894 June 21	HOWELL, F. G.	County Surveyor, Surrey. Kingston-on-Thames.
1896 Feb. 22	HOWSE, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	HUGHES, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.
1897 Jan 16	HUMPHREYS, J.	Surveyor to the Urban District Council, Maesteg.
1899 June 1	HUMPHRIES, H. H.	Surveyor to the Urban District Council, Erdington.
1894 June 21	HUNT, G. J.	Borough Engineer, Dorchester.
1897 July 8	HUNTER, T.	Surveyor to the Urban District Council, Leigh.

Date of Election and Transfer.		
1891 Aug. 1 T1896 Apr. 25	*Hurd, H.	Surveyor to the Urban District Council, Broadstairs.
1901 Aug. 24 T1901 Dec. 7	*Hutton, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
1898 Mar. 19	Huxley, J.	Surveyor to the Rural District Council, Hailsham.
1898 May 21	Ingamells, E. W...	Surveyor to the Urban District Council, Pokesdown.
1895 Apr. 20 T1896 Oct. 24	*Ingham, W., A.M. Inst.C.E.	Water Engineer, Torquay.
1899 Feb. 25	Ingram, S.	County Surveyor, Devon. Exeter.
1888 Nov. 17	Irving, W.E...	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
1898 June 24	Isaacs, L. H.	8 Verulam Buildings, Gray's Inn, W.C.
1900 July 19	Jack, G. H.	Surveyor to the Urban District Council, Aston Manor.
1893 Oct. 21	Jaffrey, W.	Town Surveyor, Matlock Bath.
1896 Oct. 24	James, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1900 Mar. 10	James, J. P.	Borough Surveyor, Tenby.
1887 Oct. 22 T1890 Mar. 29	*Jameson, M. W.	Borough Surveyor, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	Jarvis, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	Jeeves, E.	Surveyor to the Urban District Council, Melton Mowbray.
1896 Jan. 18 T1896 Oct. 24	*Jenkin, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Walton-on-Thames.
1899 June 10	Jenkins, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
1880 Feb. 7	Jennings, G.	Borough Surveyor, Rotherham.
1895 May 25	Jepson, J.	Surveyor to the Urban District Council, Levenshulme.
1892 July 21	Jevons, J. H., A. M. Inst. C.E.	Borough Surveyor, Hertford.
1895 June 27	Johnston, J., Assoc. M. Inst. C.E.	Waterworks Engineer, Brighton.
1883 Aug. 4	Jones, V.C., Lt.-Col., A. S., Assoc. M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1873 Feb. 15	JONES, C., M. Inst. C.E. *(Past President and General Hon. Secretary.)*	Borough Surveyor, Ealing, Middlesex.
1894 July 7	Jones, Christopher	Surveyor to the Urban District Council, Teignmouth.
1874 Jan. 29	Jones, I. M., M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
1894 June 21	Jones, J. P.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
1894 June 21	Jones, J. O.	Surveyor to the Rural District Council, Biggleswade.

Date of Election and Transfer.		
1900 Mar. 10	JONES, T. C.	Surveyor to the Urban District Council, Redruth.
1892 May 28	JONES, W., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Colwyn Bay.
1897 Feb. 13	JONES, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	JONES, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1891 June 25	JUKES, W. H.	Surveyor to the Urban District Council, Tipton.
1895 July 27 R1899 Dec. 16	KAY, W. R.	Athol Street, Douglas, Isle of Man.
1889 Feb. 9	KEMP, J., Assoc. M. Inst. C.E.	Engineer to the Municipality of Brisbane, Queensland.
1892 Apr. 23	KENNEDY, J. D.	Borough Surveyor, Retford.
1895 May 25	KEYWOOD, H. G.	Surveyor to the Rural District Council, Maldon.
1892 July 11	KIDD, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
1899 Oct. 21	KILLICK, J. S.	Surveyor to the Rural District Council, Maidstone.
1899 June 29	KILLICK, P. G.	Borough Surveyor, Finsbury, E.C.
1888 Sept. 15	KIRK, T., Assoc. M. Inst. C.E.	"Rushton," Lytton Road, East Brisbane, Queensland.
1892 Mar. 11	KIRKBY, S. A., M.A.	County Surveyor, Cork (South division), East Riding. Miramur, Queenstown.
1895 Oct. 19	KNAPP, R. W.	Borough Surveyor, Andover.
1894 Mar. 3	KNIGHT, J. M., A.M.Inst.C.E.	35 Bancroft Road, Mile End, E.
1884 Oct. 9	LACEY, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
1893 Jan. 14 T1895 Mar. 16	*LACEY, G. W.	Borough Surveyor, Oswestry.
1882 May 25	LAFFAN, G. B., M. Inst. C.E.	City Engineer, Pietermaritzburg.
1900 Dec. 15	LAILEY, H. G. N.	Surveyor to the Urban District Council, Heysham.
1900 July 19	LAITHWAITE, V.	Surveyor to the Urban District Council, Turton.
1891 June 6	LANDLESS, J. T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Brierfield, Lancs. Station Buildings, Nelson.
1894 June 21	LATHAM, A., M. Inst. C.E. ..	Borough Engineer, Margate.
1895 May 25	LAURENS, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cookham.
1882 Apr. 15	LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
1897 Jan. 16	LAWSON, A.W., A.M.Inst.C.E.	Borough Surveyor, Rawtenstall.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Wirksworth.
1899 Oct. 21 T1901 May 11	*LEA, M.	County Surveyor, Truro.

Date of Election and Transfer.		
1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.)
1898 Mar. 19	LEETE, H. J. G.	Market Hill, Ely, Cambs.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1900 May 19	LEGG, E. I.	Borough Surveyor, Christchurch, Hants.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.
1873 Feb. 15 R1884 Jan. 26	LEMON, J., M. Inst. C.E. (*Past President.*)	Consulting Engineer, Southampton; and 9 Victoria Street, Westminster, S.W.
1899 Oct. 21	LINES, E.	Engineer to the Rural District Council, Chesterfield.
1896 July 25 T1899 Dec. 16	*LIVERSEDGE, J. W.	Surveyor to the Urban District Council, Ashton-in-Makerfield
1891 Mar. 21	LIVINGSTONE, G., Assoc. M. Inst. C.E.	17 Victoria Street, Westminster, S.W.
1895 May 25 T1900 Oct. 15	*LOBLEY, F.	Town Surveyor, Hale, Cheshire.
1873 Feb. 15	LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall, Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	37 Cross Street, Manchester.
1896 Oct. 24	LONGFIELD, R. W. F., Assoc. M. Inst. C.E.	County Surveyor, Co. Cork (W.). Bandon.
1901 May. 11	LOVEDAY, W. F.	Borough Surveyor, Stoke Newington, N.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E.	Engineer to the Urban District Council, Hornsey, N.
1887 June 18	LOWE, C. H., M. Inst. C.E. (*Past-President.*)	30 Somerset Street, Portman Square, W.
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1884 July 10	LUND, J...	Borough Surveyor, Bedford.
1896 Oct. 24	LYNAM, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.)
1888 July 12 T1897 Oct. 16	*LYNAM, G. T., Assoc.M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1891 Aug. 1	LYNAM, P. J...	County Surveyor, Louth. Dundalk, Ireland.
1873 May 2 R1900 Mar. 10	MCBEATH, A. G., Assoc. M. Inst. C.E.	Montagu Road, Sale, Cheshire.
1883 May 30	MACBRAIR, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
1900 Feb. 10	MCDERMID, C.	Surveyor to the Urban District Council, Eston.
1897 Feb. 13	MCDONALD, A. B., M. Inst. C.E. (*Member of Council.*)	City Engineer, Glasgow.
1890 Oct. 18	MACDONALD, D. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Rugby.
1897 Jan. 16	MACKENZIE, D.	County Surveyor, Dunfermline.
1898 Oct. 15	MCKENZIE, J.	Surveyor to the Rural District Council, Wing and Eaton Bray.
1895 Oct. 19	MCKENZIE, J. McD.	Surveyor to the Rural District Council, Bucklow. 7 Market Street, Altrincham.

Date of Election and Transfer.		
1879 Oct. 23 / E1889 Oct. 19	McKie, H. U., M. Inst. C.E.	Riverdale, Ludlow, Salop.
1898 June 30	McKillop, R.	Burgh Surveyor, Perth, N.B.
1898 Feb. 19	Madin, W. B.	Surveyor to the Urban District Council, Rushden.
1897 Mar. 13	Mager, F. W.	Surveyor to the Rural District Council, Walsall.
1886 Dec. 18	Mair, H., Assoc. M. Inst. C.E.	Borough Engineer, Hammersmith, W.
1886 Oct. 16	Mallinson, J.	Surveyor to the Urban District Council, Skipton.
1891 Jan. 21 / T1897 June 19	*Manley, J.	Borough Surveyor, Wokingham.
1884 Apr. 19	Mann, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
1892 July 21	Manning, G. W.	Surveyor to the Rural District Council, Staines.
1898 Jan. 15 / T1901 Aug. 24	*Marks, C. W...	Surveyor to the Rural District Council, North-East Medene, Isle of Wight. "Brooklands," Wooton, Isle of Wight.
1888 July 12	Marks, H. C., Assoc. M. Inst. C.E.	City Surveyor, Carlisle.
1899 May 6	Marks, W. L.	Surveyor to the Urban District Council, Rhymney.
1901 May 11	Marsh, F. G...	Surveyor to the Rural District Council, Mutford and Lothingland.
1897 Mar. 13	Marshall, J...	Surveyor to the Rural District Council, West Malling.
1891 Jan. 21	Marston, C. F., Assoc. M. Inst. C.E.	44 High Street, Sutton Coldfield.
1894 Mar. 3	Marten, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Eastern District, Wandsworth. 215 High Road, Balham, S.W.
1890 Mar. 29 / E1898 Mar. 19	Mason, C., Assoc. M. Inst. C.E.	Beeston, Notts.
1899 May 6	Mason, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1890 Mar. 29	Massie, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Wakefield.
1883 Feb. 17	Mathews, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
1898 Dec. 17	*Matthews, E. R.	Surveyor to the Urban District Council, Bridlington.
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*President*)	Borough Engineer, Leicester.
1892 Mar. 11	Mawson, R. C.	Borough Surveyor, Evesham.
1883 June 28	MAY, F. J. C., M. Inst. C.E. (*Past President.*)	Borough Engineer and Surveyor, Brighton.
1894 Oct. 20	Maybury, H. P.	Surveyor to the Urban District Council, Great Malvern.
1901 Aug. 24	Maylan, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	Mayne, C., Assoc. M. Inst. C.E.	Engineer and Surveyor to the Municipal Council, Shanghai. *Hon. Corresponding Sec.* for Eastern Asia.

Date of Election and Transfer.		
1883 Feb. 17	MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester.
1888 Jan. 14 T1894 Oct. 20 R1900 Apr. 21	*MELLOR, T. E. W., Assoc. M. Inst. C.E.	Withington, Boyne Park, Tunbridge Wells.
1888 July 12	*METCALF, J. W., Assoc. M. Inst. C.E.	Town Surveyor, Newmarket.
1890 June 7	MIDDLETON, R. H., Assoc. M. Inst. C.E.	Borough Surveyor, Walsall.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1893 June 24	MILLS, J. H.	Surveyor to the Urban District Council, Crompton, near Oldham.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
1874 May 23	MITCHELL, J.	Borough Surveyor, Hyde, Manchester.
1887 July 14	MOLINEUX, W. F. Y.	Surveyor to the Rural District Council, Ulverston.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, Stafford.
1896 Jan. 18	MONSON, H., A.M. Inst. C.E.	Vestry Surveyor, St. James's, Westminster, S.W.
1900 Dec. 15	MONTEATH, G.	County Surveyor, Newtown, St. Boswell's, N.B.
1891 Oct. 17	MOORE, J. H.	County Surveyor, Co. Meath. 63 Eccles Street, Dublin.
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
1898 June 30	MORRIS, F. J...	Borough Surveyor, Grantham.
1891 Aug. 1	MORTIMER, J.	Surveyor to the Urban District Council, Tettenhall, near Wolverhampton.
1885 Feb. 7	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Withington, near Manchester.
1901 Feb. 16	*MOYNIHAN, M. A.	Surveyor to the Urban District Council, Westport, Co. Mayo.
1898 Sept. 3	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Roscommon.
1890 Mar. 29	MURCH, P.	Borough Engineer, Portsmouth.
1896 Nov. 28	MURPHY, P. E., Assoc. M. Inst. C.E.	712 High Road, Tottenham, N.
1895 Feb. 16	MURZBAN, KHAN BAHADUR, M. C., C.I.E., M. Inst. C.E.	Executive Engineer, Bombay.
1886 June 12	MYATT, J.	Town Surveyor, Leek.

Date of Election and Transfer.		
1896 Oct. 24	Nankivell, H. H.	Surveyor to the Urban District Council, Braintree.
1894 Mar. 3	*Naylor, W., A.M. Inst. C.E.	16 Walton's Parade, Preston.
1893 July 31	*Nettleton, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
1900 Feb. 10	Newey, W. F.	Surveyor to the Urban District Council, Nantwich.
1877 May 1	Newman, F.	County Surveyor, Isle of Wight. Ryde.
1897 July 8	Newman, S. J.	Surveyor to the Urban District Council, Branksome.
1897 Feb. 13	Newton, C. E.	17 Cooper Street, Manchester.
1891 Oct. 17	Newton, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
1888 May 12	Newton, W. J., A.M. Inst. C.E.	Borough Surveyor, Accrington.
1892 Sept. 24 T1899 Feb. 25	*Nichols, A. E.	Borough Engineer, Folkestone.
1887 July 14 R1899 Feb. 25	Norrington, J. P., Assoc. M. Inst. C.E.	9 Bridge Street, Westminster, S.W.
1897 Mar. 13 T1898 Sept. 3	*Norris, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18	Norrish, G. R.	Hawley House, Tudor Road, Upper Norwood.
1900 Dec. 15	Nuttall, H.	Surveyor to the Urban District Council, Kearsley.
1899 Feb. 25	Nuttall, W.	Surveyor to the Urban District Council, Prestwich.

1898 June 30 T1899 Oct. 21	*Oakden, R.	Surveyor to the Rural District Council, Newark.
1901 Aug. 24	O'Hara, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1891 Aug. 1	Orchard, W. P., B.E.	County Surveyor, Ballina, North Mayo, Ireland.
1892 Jan. 16	Oxtoby, W., A.M. Inst. C.E.	Borough Engineer, Camberwell, S.E.

1896 July 25	*Palliser, W. A...	Town Engineer, East London, Cape of Good Hope.
1896 Apr. 25	Palmer, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
1900 Mar. 10	Palmer, P. H.	Borough Surveyor, Hastings.
1894 Apr. 6	Pardoe, J. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	Parker, J., A.M. Inst. C.E.	City Surveyor, Hereford.
1887 July 14 R1895 June 27	Parker, J., A.M. Inst. C.E.	107 Bedford Court Mansions, Bedford Square, W.C.
1896 Nov. 28	Parker, J. E., A.M. Inst. C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	Parker, S. W.	Surveyor to the Urban District Council, Thornhill.
1893 July 13	Parr, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
1893 Jan. 14 T1894 Oct. 20	*Parr, N.	Surveyor to the Urban District Council, Brentford.
1898 June 30 T1899 Oct. 21	*Parr, F. H.	Surveyor to the Urban District Council, Wealdstone.

Date of Election and Transfer.		
1894 June 21	PATON, J. (*Member of Council.*)	Borough Engineer, Plymouth.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	PEACOCK, T. J.	Surveyor to the Rural District Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1894 Mar. 3	PEARSON, W. T.	Surveyor to the Urban District Council, Rothwell, Northants.
1897 Feb. 13	PEASE, C. R.	Borough Surveyor, Todmorden.
1899 Oct. 21	PEET, H. F.	City Engineer, Bloemfontein, South Africa.
1891 Dec. 12	PEIRCE, R., Assoc.M.Inst.C.E.	Municipal Engineer, Singapore.
1896 Nov. 28	PERRINS, B.	Surveyor to the Urban District Council, Redditch.
1891 Sept. 12	PERRY, J., M.E., M.Inst.C.E.	County Surveyor, Co. Galway (West Riding), Galway.
1898 May 21	PETCH, W. J.	Surveyor to the Urban District Council, Rawmarsh.
1893 Apr. 22	PETREE, M., A.M. Inst. C.E.	10 Victoria Terrace, Jarrow-on-Tyne.
1889 May 18	PHILLIPS, R., A.M. Inst. C.E.	County Surveyor, Gloucester.
1901 Oct. 19	PICKARD, J. E.	Surveyor to the Urban District Council, Baildon, Yorks.
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester. 6 Millstone Lane, Leicester.
1898 Apr. 23	PICKER, E.	Surveyor to the Rural District Council, Beverley.
1887 June 18 / T1890 Sept. 13	*PICKERING, J. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Nuneaton; *Hon. Secretary*, Midland District.
1881 Dec. 10 / R1884 May 29	PICKERING, R.	11 Lowther Street, Whitehaven.
1894 Jan. 13 / T1895 Oct. 19	*PICKERING, S. A., A.M. Inst. C.E.	Borough Surveyor, Oldham.
1894 Jan. 13 / T1895 Oct. 19	*PICKLES, G. H., A.M.Inst.C.E.	Borough Surveyor, Burnley.
1886 Sept. 11	PILDITCH, J. T.	Borough Engineer, Battersea, S.W.
1881 Dec. 10	PLATT, S. S., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale.
1893 Oct. 21	PLOWRIGHT, A. H...	Borough Engineer, Wisbech, Cambs.
1884 Mar. 15 / R1885 Oct. 3	POLLARD, J., M. Inst. C.E. ..	31 Old Queen Street, Westminster, S.W.
1897 July 8	POOLE, H. C.	Surveyor to the Urban District Council, Wath-upon-Dearn.
1881 July 7	PORTER, R.	Borough Surveyor, Wakefield.
1899 Jan. 21	POWELL, J.	4–6 Victoria Chambers, Terminus Street, East London, Cape Colony.
1891 Sept. 12	PRATT, R.	Borough Surveyor, Henley-on-Thames.
1899 Oct. 21	*PRESCOTT, A. E.	Borough Surveyor, Douglas, Isle of Man.
1898 Mar. 19	PRESCOTT, W. H.	Surveyor to the Urban District Council, Tottenham, N.

Date of Election and Transfer.		
1892 Jan. 16	Press, W. J.	Surveyor to the Urban District Council, Burnham, Somerset.
1894 June 21 ⸢1899 June 29	*Price, A. J.	Surveyor to the Urban District Council, Lytham.
1879 May 1	Price, J., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Birmingham.
1899 June 10	Priestley, C. H.	Corporation Water Engineer, Cardiff.
1873 May 2	Proctor, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1897 Feb. 13	Proffitt, J. T.	Surveyor to the Urban District Council, Worsley, Walkden, Bolton.
1892 May 28	Prouse, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1900 Oct. 15	Pullar, W. M.	Shire Engineer, Coburg, Victoria.
1873 May 2	Purnell, E. J.	Water Engineer, Coventry, Warwickshire.
1899 May 6	Purser, W. B.	County Surveyor, West Sussex. Horsham.
1893 July 31 ⸢1898 June 13	*Putman, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1897 May 15	Pym-Jones, I.	Borough Surveyor, Lymington.
1886 Dec. 18	Radford, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.
1889 July 4	Rapley, W.	Surveyor to the Rural District Council, Dorking.
1898 Apr. 23	Rayner, F. J.	Surveyor to the Urban District Council, Newhaven.
1878 May 1	Read, R., A.M. Inst. C.E. ..	City Surveyor, Gloucester.
1899 May 6	Rees, E.	Surveyor to the Urban District Council, Pontypridd.
1898 Dec. 17	Reid, R. M.	Highway Surveyor to the Stirlingshire County Council, 46 Barnton Street, Stirling.
1897 Feb. 13	Renwick, R.	Surveyor to the Urban District Council, Horsham.
1892 Mar. 11	Reynolds, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
1888 July 12	Richards, R. W., Assoc. M. Inst. C.E.	City Surveyor, Sydney, N.S.W.; *Hon. Corresponding Secretary* for Australasia.
1888 May 12	Richardson, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Handsworth.
1884 Oct. 9	Richardson, J.	Surveyor to the Urban District Council, Stamford.
1895 Apr. 20	Richardson, R.	Surveyor to the Urban District Council, Malton.
1901 May 11	Ridler, W.	Borough Surveyor, Tewkesbury.
1892 Mar. 11	Ridout, A. R.	Surveyor to the Urban District Council, Stone.
1896 Nov. 28	Roberts, D.	Borough Surveyor, Lewes.
1891 Dec. 12 ⸢1897 Mar. 13	*Roberts, F., A. M. Inst. C.E.	Borough Engineer, Worthing.
1898 Jan. 14	Robinson, A. R.	Surveyor to the Urban District Council, Clacton-on-Sea.

Date of Election and Transfer.		
1891 Oct. 17	ROBINSON, W. P.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
1886 May 1	ROBINSON, W. J.	City Surveyor, Londonderry.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1895 Jan. 19	ROSS, John C., A.M. Inst. C.E.	Town Engineer, Warrnambool, Victoria, Australia.
1889 Apr. 13	ROSS, P., Assoc. M. Inst. C.E.	District Surveyor, North Bierley, Bradford.
1892 July 11	ROTHERA, F. B.	Surveyor to the Urban District Council, Featherstone.
1880 Oct. 2	ROUNTHWAITE, R. S., Assoc. M. Inst. C.E.	City Engineer, Wellington, New Zealand.
1893 July 13	ROWLAND, J.	District Surveyor, Plumstead (Charlton Parish). 155 Church Lane, Old Charlton, Kent.
1873 May 2	ROYLE, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stretford, Lancashire.
1888 May 12	RUCK, F. W.	County Surveyor, Kent. Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	Surveyor to the Urban District Council, Cleethorpes.
1880 June 23	SADLER, G. W.	467 High Street, Cheltenham.
1890 Mar. 29	*SAISE, A. J., Assoc. M. Inst. C.E.	Surveyor, Stapleton, Bristol.
1899 Feb. 25	SALKIELD, T.	Surveyor to the Urban District Council, Hoddesdon.
1889 May 18	SASSE, G. H.	Borough Surveyor, Chelmsford.
1887 June 18 / T1898 May 21	*SAUNDERS, J.	City Surveyor, Chichester.
1884 Oct. 9	SAVAGE, W. H., A.M.Inst.C.E.	"Montfichet," East Ham, E.
1894 Mar. 3	SAVILLE, J.	Town Surveyor, Heckmondwike.
1889 May 6	SCHOFIELD, W. H.	County Surveyor, Lancashire.
1894 June 21	SCORGIE, N., A.M. Inst. C.E.	Borough Surveyor, Hackney, N.E.
1892 Sept. 24	SCOTT, A. F.	Surveyor to the Urban District Council, Cromer.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.
1901 Aug. 24	SCOTT, J. H.	Surveyor to the Urban District Council, Winton, Bournemouth.
1880 May 27	SCOTT, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	SCOTT, T.	Surveyor to the Rural District Council, Tadcaster.
1897 July 8	SENIOR, C. E...	Surveyor to the Urban District Council, Upholland.

Date of Election and Transfer.		
1896 Oct. 24	Senior, J. S.	Surveyor to the Urban District Council, Swanage.
1894 July 7 T1898 Mar. 19	*Settle, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Heywood, Manchester.
1873 Feb. 15	Sharman, E.	Surveyor to the Urban District Council, Wellingborough, Northamptonshire.
1896 Nov. 28	Sharpe, J. E.	Surveyor to the Urban District Council, Otley.
1891 June 6	Shaw, H., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Ilford.
1890 June 7	Shaw, J. H.	Shenstone Cottage, Brownhills, Staffs.
1892 May 28	Sheard, W. C., Assoc.M. Inst. C.E.	Surveyor to the Urban District Council, Heaton Norris, Stockport.
1891 Oct. 17	Shepherd, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	Sheppard, G.	Borough Surveyor, Newark.
1892 July 11	Shillington, H., M.E.	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	Shipton, T. H.	Surveyor to the Urban District Council, Oldbury.
1887 Oct. 22	Siddons, J. M.	Surveyor, Oundle.
1896 Jan. 18	Sidwell, H. T.	Surveyor to the Rural District Council, Rochford, Essex.
1887 July 14 T1898 Oct. 15	*Silcock, E. J., M. Inst. C.E.	10 Park Row, Leeds.
1897 Mar. 13	Silcock, H.	Surveyor to the Rural District Council, Blackwell, Mansfield
1901 Feb. 16	Simpson, H. F.	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1891 Aug. 1 R1895 June 27	Simpson, W. H., A. M. Inst. C.E.	Horsefair Street, Leicester.
1890 Sept. 13	Sinclair, J. S., A.M. Inst. C.E.	Borough Surveyor, Widnes.
1895 Oct. 19	Skelton, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1899 Oct. 21	Slocombe, D. W.	Surveyor to the Urban District Council, Brynmawr.
1898 Oct. 15	Smail, J. M.	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
1898 June 30	Smales, J. E.	Surveyor to the Urban District Council, Ware.
1895 June 27	Smillie, J. F.	Borough Surveyor, Tynemouth.
1899 Dec. 16	Smith, Arthur	Surveyor to the Rural District Council, Mutford and Lothingland.
1892 Mar. 11	Smith, C. Chambers	Surveyor to the Urban District Council, Sutton, Surrey.
1899 Mar. 25	Smith, H. W.	Borough Engineer, Scarborough.
1892 Mar. 11	Smith, J., Assoc. M. Inst. C.E.	County Surveyor, Co. Galway (E. Riding), Ballinasloe.
1897 May 15	Smith, J.	Borough Surveyor, Buckingham.
1895 May 25	Smith, J. B.	Surveyor to the Urban District Council, Tyldesley.
1893 July 13	Smith, J. C., A.M. Inst. C.E.	Borough Surveyor, Bury St. Edmunds.

Date of Election and Transfer.		
1899 Oct. 21	SMITH, J. D.	County Road Surveyor, Wigtownshire. 1 Newton Terrace, Stranraer.
1901 Dec. 7	SMITH, J. G.	Borough Surveyor, Beverley.
1879 May 1	SMITH, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire. *Hon. Secretary*, North Wales District.
1891 Dec. 12	SMITH, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Surveyor to the Urban District Council, Houghton-le-Spring.
1889 Dec. 14 R1898 Oct. 15	SMITH, W. H., A.M. Inst. C.E.	"Naworth," Lanercost Road, Tulse Hill Park, S.W.
1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
1887 Sept. 13	SMYTHE, F.	Surveyor to the Urban District Council, Finchley, N.
1898 Jan. 15	SNELL, J., A.M. Inst. C.E. ..	Borough Electrical Engineer, Sunderland.
1889 July 4	SOUTHAM, A., A.M. Inst. C.E.	Surveyor, Clapham, S.W.
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth.
1873 May 2 R1881 Dec. 10	SPENCER, J. P., A.M.Inst.C.E.	13 Grainger Street West, Newcastle-on-Tyne.
1885 June 25 R1888 Sept. 15	SPINKS, W., Assoc. M. Inst. C.E.	31/32 Prudential Assurance Buildings, Park Row, Leeds.
1880 Feb. 7 R1899 June 10	STAINTHORPE, T. W., A.M.Inst. C.E.	Sewerage Works, Totnes, Devon.
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	Highway Surveyor, Town Hall, Croydon.
1898 June 30	STANSFIELD-BRUN, J.	Surveyor to the Urban District Council, Oystermouth.
1892 July 21 R1900 Apr. 21	STEAD, S.	33 James Street, Harrogate.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1886 July 8	STEVENS, G.	Surveyor to the Urban District Council, Abercarn, Mon.
1890 Mar. 29	STEVENS, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
1892 Mar. 11	STEVENSON, A.	District Surveyor, Ayrshire County Council.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb, 16	STEWART, J.	Surveyor to the Urban District Council, Leighton Buzzard.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., A.M.Inst.C.E.	Borough Engineer and Surveyor, Dover.
1895 Feb. 16	STIRRAT, J.	Municipal Engineer, Rangoon.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1887 Sept. 17	STOKOE, J.	Surveyor to the Urban District Council, Altrincham.
1898 Mar. 19	STOW, J. F.	Surveyor to the Rural District Council, Uxbridge.
1893 June 24 T1893 July 13	*STRINGFELLOW, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Eastleigh, Hants.

Date of Election and Transfer.		
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
1897 Jan. 16	SUGDEN, W. L.	Surveyor to the Rural District Council, Stoke. Derby Street, Leek.
1892 July 11 / T1892 Sept. 24	*SUMNER, F., A.M. Inst. C.E.	Vestry Surveyor, Plumstead, E.
1895 Mar. 16	*SURTEES, R. T.	Wentworth Place, Hexham-on-Tyne.
1899 June 29 / T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon
1880 June 23 / R1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	80 St. Anns Street, Manchester.
1885 June 6	*SYKES, E., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Cheadle, Manchester.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1895 Mar. 16	TARBIT, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
1891 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
1891 Sept. 12 / T1897 Oct. 16	*TAYLOR, W. J., Assoc. M. Inst. C.E.	County Surveyor, Hants. Winchester.
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
1901 Feb. 16	*THOMAS, R. A.	Surveyor to the Urban District Council, Menai Bridge.
1892 Mar. 11	*THOMAS, R. J., A. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Bucks. Aylesbury. *Hon. Secretary*, Home District.
1890 May 3	THOMAS, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1887 Sept. 17	THOMAS, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath; *Hon. Secretary*, South Wales District.
1896 Mar. 21	THOMPSON, G. W., Assoc. M. Inst. C.E.	Surveyor to the Board of Works, St. Olave, Southwark; and Vestry Surveyor, Rotherhithe, S.E.
1891 Jan. 21	THORPE, J.	Surveyor to the Rural District Council, Macclesfield.
1901 June 8	THORROLD, J. F.	Surveyor to the Urban District Council, Grange-over-Sands.
1898 Jan. 15	THROPP, J.	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
1898 Apr. 23	THWAITES, W., M. Inst. C.E.	Chief Engineer to the Metropolitan Board of Works, Melbourne, Australia.
1891 June 6 / T1893 Oct. 21	*TOMES, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
1898 Apr. 23	TOMLINSON, S.	Late Municipal Engineer, Singapore.
1895 Mar. 16	TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	TOWLSON, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Cheshunt.

Date of Election and Transfer.		
1894 Oct. 20	TRAVERS, W. H.	Surveyor to the Urban District Council, Wallasey.
1897 Jan. 16	TRESIDDER, W. H.	Borough Surveyor, Falmouth.
1897 Feb. 13	TRINDER, C. D. M.	Surveyor to the Rural District Council, Claypole, Newark.
1901 Feb. 16	TROWSDALE, T. J.	Surveyor to the Urban District Council, Annfield Plain, Co. Durham.
1893 Oct. 21	TURLEY, A. C., A.M.Inst.C.E.	City Engineer, Canterbury.
1890 Oct. 18	TURNBULL, A. J.	Borough Engineer, Greenock.
1897 Mar. 13	TURNER, H. H.	Surveyor to the Rural District Council, Stockport.
1899 June 10	*TURNER, S.	Surveyor to the Urban District Council, Knaresborough, Yorkshire.
1898 June 30	TURRIFF, A. A.	Burgh Surveyor, Elgin, N.B.
1889 Sept. 21	VALLANCE, R. F.	Borough Surveyor, Mansfield.
1887 Oct. 22	VALON, W. A. MCINTOSH, Assoc. M. Inst. C.E.	Ramsgate Corporation Gas-works Engineer. 140 and 141 Temple Chambers, Temple Avenue, E.C.
1901 Mar. 23	VAWSER, C.	Surveyor to the Urban District Council, Cheriton, near Folkestone.
1894 Jan. 13 T1901 Dec. 7	*VETT, L. J.	Surveyor to the Urban District Council, Goole.
1889 Sept. 21	VENTRIS, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. "Campton," Arkwright Road, Hampstead, N.W.
1897 June 19	VINCENT, S. J. L.	Borough Surveyor, Newbury.
1898 Dec. 17	VINT, G. E.	Surveyor to the Urban District Council, Holmfirth.
1894 June 21	WADDINGTON, J. A. P., Assoc. M. Inst. C.E.	Borough Engineer, Marylebone, W.
1888 July 12	WAKELAM, H. T., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Middlesex. Guildhall, Westminster, S.W.
1898 Sept. 3	WALKER, A. H.	Borough Surveyor, Loughborough.
1873 May 2	WALKER, T., M. Inst. C.E. ..	Borough Surveyor, Croydon, Surrey.
1901 June 27	WALKER, W. L.	Surveyor to the Rural District Council, Wrexham. 2 Temple Row, Wrexham.
1889 July 4	WALLACE, G.	Borough Engineer, Holborn, E.C.
1887 June 18	WALSHAW, J. W.	Borough Surveyor, Peterborough.
1899 Jan. 21	WARD, J.	Borough Engineer, Derby.
1886 July 8	WARDLE, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
1890 May 3	WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.

Date of Election and Transfer.		
1892 Mar. 11	WATKEYS, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
1887 June 18	WATSON, J. D., Assoc. M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Council House, Birmingham.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Bishop's Stortford.
1893 Oct. 21	WATTS, W.	Water Engineer, Langsett, near Penistone.
1899 Jan. 21	WEAVER, H. J.	Borough Surveyor, King's Lynn.
1887 June 18	WEAVER, W., M. Inst. C.E. (*Vice President.*)	Borough Engineer, Kensington, W.
1900 Oct. 15	WEBB, H.	Surveyor to the Urban District Council, Halstead, Essex.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1895 May 25	WEBSTER, R. J.	District Surveyor, Castleton, Manchester.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1887 June 18	WESTON, G.	Borough Surveyor, Paddington, W.
1889 Apr. 13	WESTON, H. J., Assoc. M. Inst. C.E.	Surveyor, Southampton.
1893 Apr. 22	WETHERILL, J. W.	Borough Surveyor, Richmond, Yorks.
1887 Feb. 5	WHEELER, G. R. W., Assoc. M. Inst. C.E.	Town Hall, Westminster, S.W.
1891 Oct. 17	WHITBREAD, R.	Surveyor to the Urban District Council, Carlton, Notts.
1888 July 12	WHITE, A. E., M. Inst. C.E. ..	City Engineer, Hull.
1891 Oct. 17	WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County. Ballybrophy.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
1895 Jan. 19	WHITEHEAD, C. L., jun. ..	Surveyor, Wembley.
1899 Mar. 25	WHITTELL, F. S.	Surveyor to the Urban District Council, Worksop.
1900 Aug. 25	WHYATT, H. G. A. M. Inst. C.E.	Borough Engineer, Great Grimsby.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1884 May 29	WILKINSON, J. P.	48 Arcade Chambers, St. Mary's Gate, Manchester.
1899 Feb. 25	WILKINSON, W.	Surveyor to the Urban District Council, Altofts.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1884 Oct. 9 } t1885 June 6 }	WILCOX, J. E., Assoc. M. Inst. C.E.	63 Temple Row, Birmingham.

Date of Election and Transfer.		
1894 Mar. 3	WILLIAMS, H. DAWKIN	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
1896 Oct. 24	WILLIAMS, J.	Surveyor to the Urban District Council, Mountain Ash.
1897 May 15	WILLIAMS, M.	Surveyor to the Urban District Council, Bridgend.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
1887 Sept. 17	WILSON, G.	Surveyor to the Urban District Council, Alnwick.
1873 May 2 } R1899 Feb. 25 }	WILSON, J.	Bankside, Bacup, Lancashire.
1884 May 29	*WILSON, J. B.	Surveyor to the Rural District Council, Cockermouth.
1900 Feb. 10	WILSON, V.	Surveyor to the Urban District Council, Wardle.
1887 May 7	WINDOW, E. R., Assoc.M.Inst. C.E.	16 Cook Street, Liverpool.
1897 Oct. 16	WINNING, D.	Burgh Surveyor, Broughty Ferry, N.B.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E.	Borough Surveyor, Hampstead, N.W.
1880 Feb. 7	WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
1898 Apr. 23	WOOD, W. E.	Surveyor to the Urban District Council, Church.
1900 Feb. 10	WOODS, E. L.	Town Surveyor, Bangor, Co. Down.
1885 Oct. 3	WOODBRIDGE, C. A.	Surveyor, Pinner, Middlesex.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Penmaenmawr.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
1900 July 19 } T1901 Oct. 19 }	*WOOTTON, A. S.	Borough Surveyor, South Molton, Devon.
1893 July 13 } T1899 Oct. 21 }	*WRIGHT, J. A.	Surveyor to the Urban District Council, Horfield.
1897 Feb. 13	WYAND, B.	Surveyor to the Urban District Council, Edgware.
1892 May 28	WYNNE-ROBERTS, R. O., Assoc. M. Inst. C.E.	City Engineer, Cape Town.

1895 Jan. 19	YABBICOM, T. H., M.Inst.C.E. (*Vice President.*)	City Engineer, Bristol.

Date of Election and Transfer.		
1892 July 11 T1892 Sept. 24	*YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
1894 June 21	YORK, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1900 May 19	YOUNG, J.	Borough Surveyor, Ayr.
1899 Dec. 16	YOUNG, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	YOUNG, W. P...	Surveyor to the Urban District Council, Hoyland Nether.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

H.	*signifies*	Home District.	West	*signifies*	Western District.
Met.	„	Metropolitan District.	N.	„	Northern District.
M.	„	Midland District.	E.	„	Eastern District.
Y.	„	Yorkshire District.	W.	„	Welsh District.
L. & C.	„	Lancashire and Cheshire District.	I.	„	Irish District.
			A.	„	Abroad.

TOWN.	DISTRICT.	NAME.
Abercarne	West.	G. Stevens.
Aberdeen	N.	W. Dyack.
Abergavenny	West.	J. Haigh.
Abersychan	W.	E. Cooke.
Abingdon	H.	G. Winship.
Abram	L. & C.	G. Heaton.
Accrington	L. & C.	W. J. Newton.
Acton	H.	D. J. Ebbetts.
Aldeburgh	E.	J. C. Gordon.
Aldershot	H.	N. F. Dennis.
Alnwick	N.	G. Wilson.
Altofts	Y.	W. Wilkinson.
Altrincham	L. & C.	J. Stokoe.
Andover	H.	R. W. Knapp.
Annfield Plain	N.	T. J. Trowsdale.
Antrim (County)	I.	J. H. Brett.
Armagh	I.	J. C. Boyle.
Armagh (County)	I.	R. H. Dorman.
Ashford	H.	W. Terrill.
Ashton-under-Lyne	L. & C.	J. T. Earnshaw.
Ashton-in-Makerfield	L. & C.	J. W. Liversedge.
Ashton-on-Mersey	L. & C.	F. Hutton.
Aston Manor	M.	G. H. Jack.
Atherton	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
Axholme, Isle of (Rural)	E.	W. Atkinson.
Aylesbury	H.	J. H. Bradford.
Ayr	N.	J. Young.
Ayrshire (County)	N.	A. Stevenson.
Baildon	Y.	J. E. Pickard.
Ballymena	I.	H. O'Hara.
Banbury	H.	N. H. Dawson.
Bangor (Co. Down)	I.	E. L. Woods.
Barking	H.	C. F. Dawson.
Barnes	H.	G. B. Tomes.
Barry	W.	J. C. Pardoe.

TOWN.	DISTRICT.	NAME.
BARTON REGIS (Rural)	West.	A. P. I. Cotterell.
BARTON-UPON-IRWELL (Rural) ..	L. & C.	C. C. Hooley.
BASFORD (Rural)	M.	S. Maylan.
BASINGSTOKE	H.	G. Fitton.
" (Rural)	H.	R. Forrester.
BATTERSEA	Met.	J. T. Pilditch.
BECKENHAM	H.	J. A. Angell.
BEDFORD	H.	J. Lund.
" (County)	H.	W. H. Leete.
BEDLINGTONSHIRE	N.	C. Brown.
BELFAST	I.	J. C. Bretland.
BELPER	M.	T. Fenn.
" (Rural)	M.	R. C. Cordon.
BENWELL	N.	W. P. Pattison.
BERMONDSEY	Met.	R. J. Angel.
BERWICK-ON-TWEED	N.	R. Dickinson.
BETHNAL GREEN	Met.	F. W. Barratt.
BEVERLEY	Y.	J. G. Smith.
" (Rural)	Y.	E. Picker.
BEXHILL	H.	G. Ball.
BEXLEY	H.	W. T. Howse.
BIDDULPH	M.	S. Gibson.
BIGGLESWADE	H.	T. Cockrill.
" (Rural)	H.	J. O. Jones.
BIRKENHEAD	L. & C.	C. Brownridge.
BIRMINGHAM	M.	J. Price.
BISHOP'S CASTLE	M.	A. Hamar.
BISHOP'S STORTFORD	H.	R. S. Scott.
" " (Rural) ..	H.	E. T. Watts.
BLACKBURN	L. & C.	W. Stubbs.
BLACKPOOL	L. & C.	J. S. Brodie.
BLACKWELL (Rural)	M.	H. Silcock.
BLOEMFONTEIN, SOUTH AFRICA ..	A.	H. F. Peet.
BLYTH AND CUCKNEY (Rural) ..	M.	F. Hopkinson.
BOGNOR	H.	O. A. Bridges.
BOMBAY	A.	M. C. Murzban.
BOOTLE	L. & C.	J. A. Crowther.
BOURNEMOUTH	H.	F. W. Lacey.
BRACKLEY	M.	A. A. Green.
BRADFORD	Y.	J. H. Cox.
BRADFORD-ON-AVON	West	S. Howard.
BRAINTREE	E.	H. H. Nankivell.
BRANKSOME	West.	S. J. Newman.
BRAY	I.	P. F. Comber.
BRENTFORD	H.	N. Parr.
BRENTWOOD	E.	J. E. Fothergill.
BRIDGEND	W.	M. Williams.
BRIDGWATER	West.	F. Parr.
BRIDLINGTON	Y.	E. R. Matthews.
BRIERFIELD	L. & C.	J. T. Landless.
BRIGHTON	H.	F. J. C. May.
BRISBANE (Queensland)	A.	J. Kemp.
BRISTOL	West.	T. H. Yabbicom.
BRITON FERRY	W.	H. A. Clarke.
BROADSTAIRS	H.	H. Hurd.
BROMLEY	H.	S. T. Hawkings.
BROMYARD	M.	J. D. Barrs.
BROUGHTY FERRY, N.B.	N.	D. Winning.
BROWNHILLS	M.	W. B. Chancellor.
BRYNMAWR	W.	D. W. Slocombe.

TOWN.	DISTRICT.	NAME.
Buckhurst Hill	E.	H. Tooley.
Buckingham	M.	J. Smith.
Buckingham (County)	H.	R. J. Thomas.
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West.	W. J. Press.
Burnley	L. & C.	G. H. Pickles.
" (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T. Lynam.
Bury St. Edmunds	E.	J. C. Smith.
Buxton	M.	W. H. Grieves.
Caerphilly	W.	A. O. Harpur.
Calcutta	A.	T. C. Deverell.
Camberwell	Met.	W. Oxtoby.
Cannock, Staffs.	M.	J. S. Hendry.
Canterbury	H.	A. C. Turley.
Cape Town, S.A.	A.	R.O.Wynne-Roberts.
Cardiff	W.	W. Harpur.
" (Rural)	W.	W. Fraser.
Carlisle	N.	H. C. Marks.
Carlton	M.	R. Whitbread.
Carnarvonshire (County)	W.	E. Evans.
Castleford	Y.	W. Green.
Caversham	H.	S. P. Andrews.
Chadderton	L. & C.	W. Eckersley.
Charlton	Met.	J. Rowland.
Chatham	H.	C. Day.
Cheadle	L. & C.	E. Sykes.
Chelmsford	E.	G. H. Sasse.
" (Rural)	E.	J. Dewhirst.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West.	J. Hall.
Chepstow	W.	F. Feather.
Cheriton	H.	C. Vawser.
Chertsey	H.	J. F. Stow.
Chesham	H.	P. C. Dormer.
Cheshire (County)	L. & C.	H. F. Bull.
Cheshunt	H.	S. Towlson.
Chester	L. & C.	I. M. Jones.
Chesterfield (Rural)	M.	E. Lines.
Chesterton (Rural)	E.	J. Dunn.
Chichester	H.	J. Saunders.
Chorley	L. & C.	W. Leigh.
Christchurch	H.	E. I. Legg.
Church	L. & C.	W. E. Wood.
Clacton-on-Sea	E.	A. R. Robinson.
Clapham	Met.	A. Southam.
Clayton-le-Moors	L. & C.	A. Dodgeon.
Claypole (Rural)	E.	C. D. M. Trinder.
Cleckheaton	Y.	C. Lund.
Cleethorpes	E.	E. Rushton.
Coalville	M.	L. L. Baldwin.
Coburg (Victoria)	A.	W. M. Pullar.
Cockermouth (Rural)	N.	J. B. Wilson
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.
Colombo (Ceylon)	A.	F. A. Cooper.
" "	A.	R. Skelton.
Colwyn Bay	W.	W. Jones.

TOWN.	DISTRICT.	NAME.
Congleton	L. & C.	R. Burslam.
Conway	W.	T. B. Farrington.
Cookham (Rural)	H.	F. Laurens.
Cork	I.	H. A. Cutler.
„ (County), West	I.	R. W. Longfield.
„ „ South	I.	S. A. Kirkby.
Cottingham	Y.	J. H. Hanson.
Cowes, Isle of Wight	H.	J. W. Webster.
Cowpen	N.	R. Grieves.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Crompton	L. & C.	J. H. Mills.
Croydon	H.	T. Walker.
„ (Highways)	H.	E. F. Morgan.
„ (Rural) (Highways)	H.	S. Stallard.
„ (Rural)	H.	R. M. Chart.
Cumberland (County)	N.	G. J. Bell.
Cupar (Fife) (County)	N.	T. Aitken.
Dartford	H.	W. Harston.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Denton	L. & C.	G. H. Newton.
Derby	M.	J. Ward.
„ (County)	M.	J. S. Story.
Desborough	M.	D. J. Diver.
Devon (County)	West.	W. Ingham.
Dewsbury	Y.	H. Dearden.
Doncaster (Highways)	Y.	W. Crabtree.
„ (Rural)	Y.	C. C. Barras.
Dorchester	West.	G. J. Hunt.
Dorking	H.	G. S. Mathews.
„ (Rural)	H.	W. Rapley.
Douglas, Isle of Man	L. & C.	A. E. Prescott.
Dover	H.	H. E. Stilgoe.
Down (County)	I.	J. Heron.
Driffield (Rural)	Y.	T. C. Beaumont.
Droitwich	M.	T. P. Baylis.
Droylsden	L & C.	C. Hall.
Drumcondra	I.	M. J. Buckley.
Dublin	I.	S. Harty.
„ (County)	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire (County)	N.	A. Wilson.
Dunfermline (County)	N.	D. MacKenzie.
„	N.	A. W. Bell.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Ham	H.	A. H. Campbell.
East London, Cape Colony	A.	W. A. Palliser.
Eastleigh	H.	W. Stringfellow.
East Molesey	H.	J. Stevenson.
East Stonehouse	West.	A. W. Debnam.
East Stow (Rural)	E.	G. F. P. Harrison.
Eastbourne	H.	R. M. Gloyne.

TOWN.	DISTRICT.	NAME.
East Retford (Rural)	M.	T. Henry.
Ebbw Vale	W.	T. J. Thomas.
Edgware	H.	B. Wyand.
Elgin, N.B.	N.	A. A. Turriff.
Eltham	Met.	R. Findlay.
Enfield	H.	R. Collins.
Epsom	H.	E. R. Capon.
Erdington	M.	H. H. Humphries.
Erith	H.	H. Hind.
Eston	Y.	C. McDermid.
Eton (Rural)	H.	R. Hallam.
Eton (R.D.C.) (Highways)	H.	A. Gladwell.
Evesham	M.	R. C. Mawson.
Exeter	West.	D. Cameron.
Exmouth	West.	W. D. Harding.
Falmouth	West.	W. H. Tressider.
Fareham	H.	W Butler.
Farnborough	H.	J. E. Hargreaves.
Farnham	H.	R. W. Cass.
Featherstone	Y.	F. B. Rothera.
Felixstowe	E.	G. S. Horton.
Fenny Stratford	H.	J. Chadwick.
Fermanagh	I.	J. P. Burkitt.
Filey	Y.	A. S. Clarson.
Finchley	H.	F. Smythe.
Finsbury	Met.	P. G. Killick.
Folkestone	H.	A. E. Nichols.
Friern Barnet	H.	E. J. Reynolds.
Frome	West.	P. Edinger.
Fulham	Met.	C. Botterill.
Galway (County), West	I.	J. Perry.
" " East	I.	J. Smith.
Gateshead-on-Tyne	N.	J. Bower.
Glamorgan (County)	W.	T. L. Edwards.
Glasgow	N.	A. B. McDonald.
Glastonbury	West.	G. Alves.
Gloucester	West.	R. Read.
" (County)	West.	R. Phillips.
Glyncorrwg	W.	W. P. Jones.
Godalming	H.	J. H. Norris.
Goole	Y.	L. J. Veit.
Gosforth	N.	C. J. Baff.
Gosport and Alverstoke	H.	H. Frost.
Grange-over-Sands	L. & C.	J. F. Thorrold.
Grantham	E.	F. J. Morris.
Gravesend	H.	F. T. Grant.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	H. G. Whyatt.
Great Yarmouth	E.	J. W. Cockrill.
Greenock	N.	A. J. Turnbull.
Grey County, New Zealand	A.	J. Higgins.
Guernsey	H.	T. J. Guilbert.
Guildford	H.	C. G. Mason.
" (Rural)	H.	J. Anstee.
Guiseley	Y.	J. C. Haller.

TOWN.	DISTRICT.	NAME.
Hackney	Met.	N. Scorgie.
Hailsham (Rural)	H.	J. Huxley.
Hale	L. & C.	F. Lobley.
Halifax (Rural)	Y.	F. Gordon.
Halstead	E.	H. Webb.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	O. E. Winter.
Hampton Wick	H.	J. N. Horsfield.
Handsworth	M.	H. Richardson.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrow	H.	J. P. Bennetts.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	J. S. Green.
Hastings	H.	P. H. Palmer.
Hawick	N.	Chas. Brown.
Hayward's Heath	H.	H. W. Bowen.
Heaton Norris	L. & C.	W. C. Sheard.
Hebden Bridge	Y.	W. Calvert.
Heckmondwike	Y.	J. Saville.
Hemel Hempstead	M.	W. R. Locke.
Hendon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed *viâ* Cardiff (Rural)	W.	J. P. Jones.
Henley-on-Thames	H.	R. Pratt.
Hereford	M.	J. Parker.
„ (County)	M.	A. Dryland.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Heysham	L. & C.	H. G. N. Lailey.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Higham Ferrers	M.	C. Dunkley.
Hinckley	M.	F. C. Cook.
Hoddesdon	E.	T. Salkield.
Holborn	Met.	G. Wallace.
Holmfirth	Y.	G. E. Vint.
Holyhead	W.	A. Asquith.
Horfield	West.	J. A. Wright.
Hornsea	Y.	P. Gaskell.
Hornsey	Met.	E. J. Lovegrove.
Horsham	H.	R. Renwick.
Houghton-le-Spring	N.	V. Smith.
Hove	H.	H. H. Scott.
Howrah (Bengal)	A.	F. Cartwright.
Hoylake and West Kirby	L. & C.	T. Foster.
Hoyland Nether	Y.	W. P. Young.
Huddersfield	Y.	K. F. Campbell.
„ (Gas)	Y.	E. A. Harman.
Hull	Y.	A. E. White.
Hyde	L. & C.	J. Mitchell.
Hythe	H.	A. S. Butterworth.
Ilford	E.	H. Shaw.
Ilfracombe	West.	O. M. Prouse.
Ipswich	E.	E. Buckham.
Isle of Thanet (Rural)	H.	F. T. Elliott.
Isle of Ely (N.) (County)	E.	H. F. Simpson.

TOWN.	DISTRICT.	NAME.
Isle of Wight (County)	H.	F. Newman.
Islington	Met.	J. P. Barber.
Itchen	H.	T. A. Collingwood.
Kearsley	L. & C.	H. Nuttall.
Keighley	Y.	W. H. Hopkinson.
Kendal	N.	R. H. Clucas.
Kensington	Met.	W. Weaver.
Kent (County)	H.	F. W. Ruck.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West.	H. M. Bennett.
Kidderminster (Rural)	M.	A. Comber.
Kilkenny (County)	I.	A. M. Burden.
King's Lynn	E.	H. J. Weaver.
Kingston (Highways)	H.	A. J. Henderson.
Kingston-on-Thames (Rural) ..	H.	W. H. Hope.
King's Norton	M.	A. W. Cross.
Kingston, Jamaica	A.	C. V. Abrahams.
Kirkcaldy	N.	J. L. Lumsden.
Knaresborough	Y.	S. Turner.
Lancashire (County)	L. & C.	W. H. Schofield.
Lancaster	L. & C.	J. Cook.
Lanchester (Highways)	N.	W. Cumming.
Lee	M.	W. G. Forder.
Leeds	Y.	T. Hewson.
Leek	M.	J. Myatt.
Leicester	M.	E. G. Mawbey.
„ (County)	M.	S. P. Pick.
Leigh	L. & C.	T. Hunter.
Leighton Buzzard	H.	J. Stewart.
Leith	N.	W. Beatson.
Leitrim (County)	I.	E. O'N. Clarke.
Levenshulme	L. & C.	J. Jephson.
Lewes	H.	D. Roberts.
Lewisham	Met.	J. Carline.
Leyland	L. & C.	W. H. Wilkinson.
Leyton	H.	W. Dawson.
Limerick (County)	I.	J. Horan.
Lincoln	E.	R. A. MacBrair.
„ (County)	E.	J. Thropp.
Littleborough	L. & C.	G. H. Wild.
Littlehampton	H.	H. Howard.
Liverpool	L. & C.	J. A. Brodie.
Llandaff (Rural)	W.	W. Fraser.
Llandaff (Rural) (Highways) ..	W.	J. Holden.
Llandudno	W.	E. P. Stephenson.
Llanelly	W.	G. Watkeys.
Llantrissant	W.	G. S. Morgan.
Loftus	Y.	T. H. Tarbit.
London (County)	Met.	Sir A. R. Binnie.
Londonderry	I.	W. J. Robinson.
Long Crendon (Rural)	H.	A. J. Dickinson.
Longford (County)	I.	J. W. Gunnis.
Longton	M.	J. W. Wardle.
Loughborough	M.	A. H. Walker.
Louth (County)	I.	P. J. Lynam.

TOWN.	DISTRICT.	NAME.
Lower Bebington	L. & C.	H. W. Corrie.
Lowestoft	E.	G. H. Hamby.
Lurgan	I.	H. Shillington.
Luton	H.	A. J. L. Evans.
Lymington	H.	I. Pym-Jones.
Lynton	West.	W. H. Chowins.
Lytham	L. & C.	A. J. Price.
Macclesfield	L. & C.	E. E. Adshead.
„ (Rural)	L. & C.	J. Thorpe.
Maesteg	W.	J. Humphreys.
Maidstone	H.	T. F. Bunting.
„ (Rural)	H.	J. S. Killick.
Maldon	E.	T. R. Swales.
„ (Rural)	E.	H. G. Keywood.
Malton	H.	R. Richardson.
Malvern	M.	H. P. Maybury.
Manchester	L. & C.	T. De C. Meade.
Mansfield	M.	R. F. Vallance.
Mansfield Woodhouse	M.	F. P. Cook.
Margam, Port Talbot	W.	J. Cox.
Margate	H.	A. Latham.
Market Harborough	M.	H. G. Coales.
Marylebone	Met.	J. A. P. Waddington
Matlock	M.	J. Diggle.
Matlock Bath	M.	W. Jaffrey.
Meath (County)	I.	J. H. Moore.
Melbourne	A.	W. Thwaites.
Melton Mowbray	M.	E. Jeeves.
Menai Bridge	W.	R. A. Thomas.
Merthyr Tydvil	W.	T. F. Harvey.
Methley	Y.	T. W. Nichols.
Mexborough	Y.	G. F. Carter.
Middlesbrough	Y.	F. Baker.
Middlesex (County)	H.	H. T. Wakelam.
Middleton	L. & C.	W. Welburn.
Midhurst (Rural)	H.	A. G. Gibbs.
Midsomer Norton	West.	W. F. Bird.
Mile End	Met.	J. M. Knight.
Milton-next-Sittingbourne	H.	W. A. Farnham.
Monmouthshire (County)	W.	W. Tanner.
Montgomery	W.	W. P. Hole.
Morley	Y.	W. E. Putman.
Mountain Ash	W.	J. Williams.
Mutford & Lothingland (Rural)	E.	F. G. Marsh.
Nantwich	L. & C.	W. F. Newey.
Neath	W.	D. M. Jenkins.
„ (Rural)	W.	W. E. C. Thomas.
Nelson	L. & C.	B. Ball.
New Swindon	H.	H. J. Hamp.
Newark	M.	G. Sheppard.
„ (Rural)	M.	R. Oakden.
Newburn-on-Tyne	N.	T. Gregory.
Newbury	H.	S. J. L. Vincent.
Newcastle-on-Tyne	N.	W. G. Laws.
Newhaven	H.	F. J. Rayner.

TOWN.	DISTRICT.	NAME.
Newmarket	E.	J. W. Metcalf.
Newport, Mon.	West.	R. H. Haynes.
Newton Abbot	West.	L. Stevens.
Newtown St. Boswells, N.B.	N.	G. Monteath.
Norfolk (County)	E.	T. H. B. Heslop.
North East Medene, I.W. (Rural)	H.	C. W. Marks.
North Mayo (County)	I.	W. P. Orchard.
Northallerton	Y.	D. Hinchcliffe.
Northampton	M.	W. I. Brown.
Northwich	L. & C.	J. Brooke.
Norwich	E.	A. E. Collins.
Nottingham	M.	A. Brown.
" (County)	M.	E. P. Hooley.
Nuneaton	M.	J. S. Pickering.
Oakworth	Y.	J. Spencer.
Ogmore and Garrw	W.	H. D. Williams.
Okehampton	West.	H. Geen.
Oldbury	M.	T. H. Shipton.
Oldham	L. & C.	S. A. Pickering.
Oswestry	M.	G. W. Lacey.
Otley	Y.	J. E. Sharp.
Oxford	H.	W. H. White.
Oystermouth	W.	J. Stansfield-Brun.
Paddington	Met.	G. Weston.
Padiham	L. & C.	J. Gregson.
Partick	N.	J. Bryce.
Peebles (County)	N.	R. S. Anderson.
Pemberton	L. & C.	G. Heaton.
Penarth	W.	E. I. Evans.
Penmaenmawr	W.	E. Worrall.
Perry Barr	M.	H. H. Gammell.
Perth, N.B.	N.	R. McKillop.
Pietermaritzburg	A.	G. B. Laffan.
Peterborough	M.	J. W. Walshaw.
Plumstead	Met.	W. C. Gow.
"	Met.	F. Summer.
Plymouth	West.	J. Paton.
Pokesdown	H.	E. W. Ingamells.
Pontardawe (Rural)	W.	J. Morgan.
Pontypridd	W.	E. Rees.
Poole	West.	J. Elford.
Poplar	Met.	O. E. Winter.
Portmadoc	W.	T. Harris.
Portslade-by-Sea	H.	A. T. Allen.
Portland	West.	E. J. Elford.
Portsmouth	H.	P. Murch.
Prescot	L. & C.	W. Goldsworth.
Prestwich	L. & C.	W. Nuttall.
Putney	Met.	J. C. Radford.
Pwllheli	W.	W. J. Davies.
Queen's County	I.	H. V. White.
Queenstown, South Africa ..	A.	W. A. Palliser.

TOWN.	DISTRICT.	NAME.
Rangoon	A.	J. Stirrat.
Rawmarsh	Y.	W. J. Petch.
Rawtenstall	L. & C.	A. W. Lawson.
Redditch	M.	B. Perrins.
Redcar	Y.	J. Howcroft.
Redruth	West.	T. C. Jones.
Reigate	H.	F. T. Clayton.
Retford	M.	J. D. Kennedy.
Rhondda	W.	W. J. Jones.
Rhymney	W.	W. L. Marks.
Richmond, Surrey	H.	J. H. Brierley.
Richmond, Yorks	Y.	J. W. Wetherill.
Ripon	Y.	W. Edson.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Rochford (Rural)	H.	H. T. Sidwell.
Romford (Rural)	E.	E. G. Boden.
Roscommon (County)	I.	C. J. Mulvany.
Rotherham	Y.	G. Jennings.
„ (Rural)	Y.	B. Godfrey.
Rotherithe	Met.	G. W. Thompson.
Rothwell, Northants	M.	W. T. Pearson.
Rowley Regis	M.	W. H. Brettell.
Rugby	M.	D. G. MacDonald.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
Rushden	M.	W. B. Madin.
Ryton-on-Tyne	N.	J. P. Dalton.
St. Albans	H.	G. Ford.
St. Helens, Lancs.	L. & C.	G. J. C. Broom.
„ Isle of Wight	H.	J. I. Barton.
St. Neots (Hunts)	L.	A. T. Blood.
St. Pancras	Met.	W. N. Blair.
Saffron Walden	E.	A. H. Forbes.
Sale	L. & C.	W. Holt.
Salford	L. & C.	J. Corbett.
Saltburn-by-the-Sea	Y.	G. S. L. Bains.
Sandgate	H.	A. R. Bowles.
Scarborough	Y.	H. W. Smith.
Sevenoaks	H.	J. Mann.
Shanghai, China	A.	C. Mayne.
Shanklin	H.	E. C. Cooper.
Sheffield	Y.	C. F. Wike.
Sherborne	West.	T. Farrall.
Shoreditch	Met.	J. R. Dixon.
Shrewsbury	M.	W. C. Eddowes.
Shropshire (County)	M.	A. T. Davis.
Singapore	A.	R. Peirce.
Skelton-in-Cleveland	Y.	W. P. Robinson.
Skipton	Y.	J. Mallinson.
„ (Rural)	Y.	A. Rodwell.
Sleaford	E.	J. Clare.
Slough	H.	W. W. Cooper.
Smallthorne	M.	J. Deane.
Smethwick	M.	C. J. Fox-Allin.
Soothill Upper	Y.	J. Blackburn.
Solihull (Rural)	M.	A. E. Currall.
South Shields	N.	S. E. Burgess.

TOWN.	DISTRICT.	NAME.
Southall Norwood	H.	H. R. Felkin.
Southampton	H.	W. B. G. Bennett.
Southend-on-Sea	H.	A. Fidler.
Southgate	H.	C. G. Lawson.
Southowram	Y.	W. H. D. Horsfall.
South Molton	West.	A. S. Wootton.
Southport	L. & C.	R. P. Hirst.
Southwark	Met.	A. Harrison.
,, St. Olave	Met.	G. W. Thompson.
Southwold	E.	F. Ball.
Spalding	E.	J. S. Hélé.
,, (Rural)	E.	T. J. Peacock.
Spilsby (Rural)	E.	T. A. Busbridge.
Stafford	M.	W. Blackshaw.
Stafford (County) (Highways)	M.	J. Moncur.
Staines	H.	E. J. Barrett.
,, (Rural)	H.	G. W. Manning.
Stalybridge	L. & C.	J. N. White.
Stamford	E.	J. Richardson.
Stepney	Met.	M. W. Jameson.
Stirling	N.	A. H. Gondie.
Stirlingshire (Highways)	N.	R. M. Reid.
Stockport	L. & C.	J. Atkinson.
Stockport (Rural)	L. & C.	H. H. Turner.
Stockton-on-Tees	N.	M. H. Sykes.
Stoke (Rural)	M.	W. L. Sugden.
Stoke Newington	Met.	W. F. Loveday.
Stone	L. & C.	A. R. Ridout.
Stourbridge	M.	F. Woodward.
Strand	Met.	A. Ventris.
Stratford-on-Avon	M.	R. Dixon.
Stretford	M.	H. Royle.
Strood (Rural)	H.	W. Brooke.
Stroud	West.	G. P. Milnes.
Sudbury (Suffolk)	E.	T. W. A. Hayward.
Suffolk (County), East	E.	H. Miller.
Sunbury-on-Thames	H.	H. F. Coales.
Sunderland (Rural)	N.	T. Young.
Surrey (County)	H.	F. G. Howell.
Sussex (County), East	H.	F. J. Wood.
,, (County), West	H.	W. B. Purser.
Sutton	H.	C. C. Smith.
Sutton Coldfield	M.	W. A. H. Clarry.
Sutton-in-Ashfield	M.	McW. Bishop.
Swadlincote	M.	T. Kidd.
Swanage	West.	J. S. Senior.
Swansea	W.	G. Bell.
Swinton	L. & C.	H. Entwisle.
Sydney, N.S.W.	A.	R. W. Richards.
,, ,,	A.	J. M. Smail.
Tadcaster (Rural)	Y.	T. Scott.
Tamworth	M.	H. J. Clarson.
Teddington	H.	M. Hainsworth.
Teignmouth	West.	C. Jones.
Tenbury (Rural)	M.	R. W. Jarvis.
Tenby	W.	J. P. James.
Tettenhall	M.	J. Mortimer.
Tewkesbury	West.	W. Ridler.

TOWN.	DISTRICT.	NAME.
THORNHILL	Y.	S. W. Parker.
TIENTSIN, CHINA	A.	A. W. H. Bellingham.
TIPPERARY (County), South	I.	E. A. Hackett.
TIPTON	M.	W. H. Jukes.
TODMORDEN	L. & C.	C. R. Pease.
TONBRIDGE	H.	W. L. Bradley.
„	H.	A. F. Ginn.
„ (Rural)	H.	F. Harris.
TOOWONG, QUEENSLAND	A.	W. E. Irving.
TOKIO FU, JAPAN	A.	R. Hara.
TOTTENHAM	H.	W. H. Prescott.
TOWYN	W.	R. P. Morgan.
TROWBRIDGE	West.	F. E. G. Bradshaw.
TRURO (County)	West.	M. Lea.
TUNSTALL	M.	A. R. Wood.
TURTON	L. & C.	V. Laithwaite.
TWICKENHAM	H.	F. W. Pearce.
TYLDESLEY	L. & C.	J. B. Smith.
TYNEMOUTH	N.	J. F. Smillie.
TYRONE (County) North	I.	F. J. Lynam.
„ „ South	I.	J. W. Leebody.
UPHOLLAND	L. & C.	C. E. Senior.
URMSTON	L. & C.	J. Heath.
UXBRIDGE (Rural) (Highways)	H.	E. Birks.
ULVERSTON (Rural)	L. & C.	W. F. Y. Molineux.
VENTNOR	H.	E. J. Harvey.
WAKEFIELD	Y.	R. Porter.
„ (Rural)	Y.	F. Massie.
WALLASEY	L. & C.	W. H. Travers.
WALSALL	M.	R. H. Middleton.
„ (Rural)	N.	F. W. Mager.
WALLSEND	N.	G. Hollings.
WALTHAMSTOW	H.	G. W. Holmes.
WALTON-ON-THAMES	H.	C. J. Jenkin.
WANDSWORTH (Eastern)	Met.	H. J. Marten.
„ (Western)	Met.	P. Dodd.
WANSTEAD	H.	J. T. Bressey.
WANTAGE (Rural)	H.	W. Hanson.
WARDLE	L. & C.	V. Wilson.
WARE	H.	J. E. Smales.
WARWICKSHIRE (County)	M.	J. Willmot.
WARRNAMBOOL, MELBOURNE	A.	J. C. Ross.
WATERFORD	I.	M. J. Fleming.
„ (County)	I.	W. E. L. Duffin.
WATERLOO, LIVERPOOL	L. & C.	F. S. Yates.
WATFORD	H.	D. Waterhouse.
WATH-UPON-DEARNE	Y.	H. C. Poole.
WEALDSTONE	H.	F. H. Parr.
WELLINGBOROUGH	M.	E. Sharman.
WELLINGTON, NEW ZEALAND	A.	R. S. Rounthwaite.
WEMBLEY	H.	C. R. W. Chapman.
WEST BROMWICH	M.	A. D. Greatorex.

TOWN.	DISTRICT.	NAME.
West Hartlepool	N.	J. W. Brown.
West Malling (Rural)	H.	J. Marshall.
Westminster	Met.	J. W. Bradley.
Weston-super-Mare	West.	H. Nettleton.
Westport (Co. Mayo)	I.	M. A. Moynihan.
Weymouth and Melcombe Regis	West.	W. B. Morgan.
Whitehaven	N.	E. E. Stiven.
Whitworth	L. & C.	T. Biker.
Widnes	L. & C.	J. S. Sinclair.
Wigtownshire (Highways) ..	N.	J. D. Smith.
Willenhall	M.	T. E. Fellows.
Willesden	H.	O. C. Robson.
Willington Quay	N.	J. F. Davidson.
Wilmslow	L. & C.	A. S. Cartwright.
Wimbledon	H.	C. H. Cooper.
Winchester..	H.	W. V. Anderson.
„ (Rural)	H.	G. E. Carter.
Windsor	H.	E. A. Stickland.
Wing and Eaton Bray (Rural)	H.	J. McKenzie.
Winton	H.	J. H. Scott.
Wirksworth	M.	C. H. Lawton.
Wisbech	E.	A. H. Plowright.
Withington	L. & C.	A. H. Mountain.
Witney	H.	G. A. Graham.
Wokingham	M.	J. Manley.
Wolverhampton	M.	G. Green.
Wood Green..	H.	C. J. Gunyon.
Woodford	E.	W. Farrington.
Woollahra, Sydney	A.	J. I. Haycroft.
Worcester	M.	T. Caink.
„ (County)	M.	J. H. Garrett.
Worksop..	M.	F. S. Whittell.
Worsley..	L. & C.	J. T. Proffitt.
Worthing	H.	F. Roberts.
Wortley (Rural)	Y.	G. E. Beaumont.
Wrexham	W.	J. W. M. Smith.
„ (Rural)	W.	W. L. Walker.
Yeovil	W.	W. K. L. Armytage.
York	Y.	A. Creer.
Yorkshire, East Riding	Y.	A. Beaumont.
„ West Riding	Y.	J. V. Edwards.

ASSOCIATES.

* *Those Associates against whose names a star is placed have obtained the certificate of the Association.*

Date of Election and Transfer.		
1901 Oct. 19	Ashbee, W.	Briarside, Hanwell, W.
1897 July 31 T1901 Oct. 19	*Bentley, J. H., A. M. Inst. C.E.	Town Hall, Oldham.
1898 June 30 T1901 Oct. 19	*Best, H. Storr	Council Offices, Beckenham, S.E.
1897 June 9 T1901 Dec. 7	*Bissell, W. S.	Borough Surveyor's Office, Wolverhampton.
1898 June 30 T1901 Dec. 7	*Bowe, D. J.	Borough Engineer's Office, Eastbourne.
1892 July 11 T1901 Dec. 7	*Carter, G. F.	Borough Engineer's Office, Croydon.
1900 May 19 T1901 Oct. 19	*Coombs, C. A.	Town Hall, Todmorden, Yorks.
1897 Feb. 13 T1901 Oct. 19	*Collis-Adamson, A. C. ..	Council Offices, Hornsey, N.
1901 Aug. 24 T1901 Oct. 19	*Cox, A. L.	Borough Engineer's Office, Folkestone.
1901 Oct. 19	*Croxford, C. H.	Town Hall, Wood Green, N.
1898 Dec. 17 T1901 Dec. 7	*Ellison, D.	Borough Engineer's Office, West Bromwich.
1896 June 25 T1901 Dec. 7	*Fell, P. O.	City Engineer's Office, Norwich.
1901 June 8 T1901 Oct. 19	*Fowlds, W.	Borough Engineer's Office, Keighley.
1901 Dec. 7	Greenshields, A.	Council House, Birmingham.
1893 Jan. 14 T1901 Oct. 19	*Greenwood, J. P.	Town Hall, Burnley.
1897 June 19 T1901 Oct. 19	*Haigh, W. H.	Town Hall, Cardiff.
1900 June 16 T1901 Oct. 19	*Jerram, G.	Town Hall, Walthamstow, N.E.
1901 Dec. 7	Lashmore, E. A.	District Surveyor, Bristol.
1901 May 11 T1901 Oct. 19	*Lismer, A. B.	Town Hall, Croydon.
1900 Apr. 21 T1901 Dec. 7	*Miller, G. F.	Borough Engineer's Office, Hastings.
1898 Dec. 17 T1901 Oct. 19	*Mitchell, G.	Municipal Offices, Warrington.
1895 Jan. 19 T1901 Oct. 19	*Newton, E. B. B., A.M. Inst. C.E.	Town Hall, Paddington, W.
1895 Jan. 19 T1901 Oct. 19	*Perkins, J.	Council House, Birmingham.

Date of Election and Transfer.		
1897 June 19 / T1901 Dec. 7	*REDFERN, J. L.	City Engineer's Office, Carlisle.
1899 Dec. 16 / T1901 Oct. 19	*SLATER, F. J.	Town Hall, Camberwell, S.E.
1898 Dec. 17 / T1901 Oct. 19	*SMITH, J. W.	Town Hall, Barrow-in-Furness.
1899 Dec. 16 / T1901 Oct. 19	*SPRECKLEY, J. A., A. M. Inst. C.E.	City Surveyor's Office, Hereford.
1901 Dec. 7	SPURR, F. W.	City Engineer's Office, York.
1895 Jan. 19 / T1901 Oct. 19	*STEELE, W. J., A.M. Inst. C.E.	City Engineer's Office, Bristol.
1898 June 30 / T1901 Dec. 7	*WILLIS, E.	Council Offices, Willesden, N.W.
1898 June 30 / T1901 Dec. 7	*WILSON, F.	District Surveyor, Bristol.
1891 Aug. 1 / T1901 Oct. 19	*YARWOOD, H.	Town Hall, Rochdale.

GRADUATES.

Date of Election.		
1893 Oct. 2	Ball, J. B., A.M. Inst. C.E.	Engineer's Office, L.D. & E.C. Railway, Chesterfield.
1901 Aug. 24	Barker, H. W.	Surveyor to the Urban District Council, Walmer.
1890 Mar. 29	Bayley, G. H., A.M.Inst.C.E.	17 Cooper Street, Manchester.
1901 June 8	Beacham, W. E.	Town Hall, Rochdale.
1897 July 31	Beard, E. T., A.M. Inst. C.E.	"Marazion," West Hill, St. Leonards-on-Sea.
1898 Dec. 17	Bell, B.	City Surveyor's Office, Carlisle.
1893 June 24	Birch, J.	Public Offices, East Ham, E.
1900 June 16	Blakeway-Phillips, R. ..	Borough Engineer's Office, Middlesbrough.
1901 Aug. 24	Blanchard, R.	98 Laurel Road, Leicester.
1889 June 8	Blizard, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1899 June 10	Bradshaw, A. S.	Borough Engineer's Office, Bedford.
1892 Oct. 15	Bradshaw, J. B., A.M. Inst. C.E.	Headquarters, R. E. Office, Bermuda.
1898 June 30	Briscoe, J. T.	"Laurel Dene," Southbury Road, Enfield, N.
1896 June 25	Bruce, W...	Borough Engineer's Office, Edinburgh.
1889 July 4	Bryans, J. G.	Assistant Engineer, Buenos Ayres and Pacific Railway, Junin, Argentine.
1899 Feb. 9	Bryning, W. G.	County Surveyor, Yorks, North Riding, Northallerton.
1899 June 29	Burgess, R. W.	Town Hall, Stratford, E.
1895 Jan. 19	Burton, A., A.M. Inst. C.E.	Borough Engineer, Stoke-upon-Trent.
1899 June 29	Bush, W. E.	City Surveyor's Office, Birmingham.
1897 June 19	Cartledge, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1890 Sept. 13	Catchpole, J. H.	27 Avenue Villas, Avenue Road, Finchley, N.
1894 Oct. 20	Chasemore, A. E.	98 High Street, Putney, S.W.
1894 July 7	Claypoole, A. H., A. M. Inst. C.E.	City Engineer's Office, Bristol.
1894 July 7	Clegg, H.	Borough Surveyor's Office, Oldham.
1898 Dec. 17	Clews, C. A.	Borough Engineer's Office, Derby.
1899 June 29	Collinge, T. P.	Town Hall, Nelson.
1899 Oct. 21	Cowan, G.	47 Chelsea Road, Southsea.
1897 June 19	Cresswell, W. T.	Divisional Office, R.E., Weedon.
1892 July 11	Cross, F. W., A.M. Inst. C.E.	45 Bradford Street, Walsall.
1900 June 19	Crump, E. H...	Council Offices, Nuneaton.

Date of Election.		
1898 June 30	Cudbird, T. O.	The Refuge, Caernarvon Road, Norwich.
1901 June 8	Davidge, W. R.	Council Offices, Teddington.
1898 June 30	Dent, J. P.	24 Lomeshaye Road, Nelson, Lancashire.
1891 Dec. 12	Dolamore, F.	Borough Engineer's Office, Bournemouth.
1899 June 29	Dyer, R. H.	Borough Engineer's Office, Southampton.
1898 Feb. 19	Endsor, H. A.	2 Oakland Villas, Rosebery Road, Norwich.
1898 Dec. 17	Essex, E. H.	Town Hall, Leyton, N.E.
1886 Sept. 11	Fenton, W. C.	10 Paradise Square, Sheffield.
1891 June 25	Finch, A. R., A.M. Inst. C.E.	Town Hall, Kensington, W.
1898 June 30	Finch, E. E.	Town Hall, Bermondsey, S.E.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1899 Oct. 21	Foster, H. H.	Borough Engineer's Office, West Hartlepool.
1896 Jan. 18	Fox, Senior L.	Town Hall, Newport.
1895 May 25	Franck-Clark, A. H.	District Engineer, P. W. D., Ratnapura, Ceylon.
1898 June 30	Fraser, R. W.	Town Hall, Wolverhampton.
1901 May 11	Gair, J.	Town Hall, Hammersmith, W.
1899 June 10	Gibson, W. S.	"D'Arcyville," Victoria Road, Hendon.
1890 June 7	Gibbs, L., Assoc. M. Inst. C.E.	c/o Messrs. Denison and Ram, Hong Kong.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1898 Jan. 15	Godfrey, O.H., A.M.Inst.C.E.	Municipal Offices, Shanghai.
1899 Dec. 16	Goodfellow, H.	Borough Surveyor's Office, Southport.
1894 Jan. 13	Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Town House, Aberdeen.
1898 Jan. 15	Grimley, F. C.	The Depôt, Harwich.
1901 June 27	Harlow, W. W. R.	Council Offices, High Street, Grays.
1899 Oct. 21	Harper, A.	Deputy Borough Surveyor, St. Helen's, Lancs.
1901 June 8	Harris, K. J. S.	Town Hall, Great Yarmouth.
1900 May 19	Harrison, J. W.	106 Raffles Road, Tranmere, Birkenhead.
1899 Jan. 12	Haywood, S. S.	Borough Engineer's Office, Darwen.
1893 Jan. 14	Hellawell, O.	Town Hall, Withington, Manchester.
1892 May 28	Hills, H. J., A.M. Inst. C.E.	21 Gloucester Road, Philip Lane, Tottenham, N.
1896 June 25	Hills, O. C.	147 Bow Road, E.
1900 Mar. 10	Hinchcliff, E. R...	Council Offices, Barry, Glam.
1900 June 16	Hobson, E.	The Gables, Dykes Hall Road, Hillsborough, Sheffield.
1900 Aug. 25	Holloway, W. C.	Engineer's Office, Kettering.
1888 July 12	Houghton, J.	King's Heath, Birmingham.
1901 Aug. 24	Hull, G. E.	1 Wyndham Road, Edgbaston, Birmingham.
1899 June 10	Hutchings, W. A...	Town Hall, Islington, N.
1898 Jan. 15	Jeffes, R. H.	242 High Street, Acton.
1895 July 27	Jenkins, A. J., A.M.Inst.C.E.	Town Hall, Burton-on-Trent.
1897 July 31	Jenkins, R. J.	Town Hall, Portsmouth.
1901 May 11	Johnston, C.	55 Ashborne Street, Leicester.

Date of Election.		
1897 June 19	JOHNSTON, R. W.	Borough Surveyor's Office, Birkenhead.
1901 June 8	JONES, H. O.	Town Hall, Hove.
1895 Oct. 19	JULIAN, J.	Borough Surveyor's Office, Cambridge.
1896 June 25	KIESER, W. H. G.	City Engineer's Office, Bristol.
1893 June 24	KILLICK, W. H.	Borough Surveyor's Office, Southampton.
1896 June 25	KIRK, J. W.	Town Hall, Westminster, S.W.
1900 Dec. 15	MACDONALD, K. G.	13 Charles Street, St. James's, S.W.
1894 Jan. 13	MARTIN, E. B., A.M.Inst.C.E.	City Engineer's Office, Leeds.
1900 June 16	MATTINSON, H.	55 Piccadilly, Manchester.
1896 July 25	MAXWELL, W. H., A. M. Inst. C.E.	Borough Engineer, Town Hall, Tunbridge Wells.
1898 Dec. 17	MAY, C. G.	P.W.D., Malacca, Straits Settlements.
1901 Oct. 19	MILNES, B.	Town Hall, Birkenhead.
1899 June 10	MOSS, P. A.	121 Highbury Hill, Highbury, N.
1901 Aug. 24	NEAVE, J.	"Weston," New London Road, Chelmsford.
1896 June 25	NIGHTINGALE, C. F.	6 Westbourne Road, Walsall.
1895 June 27	OPENSHAW, J., A.M.Inst.C.E.	Borough Engineer's Office, Salford.
1901 Aug. 24	OXBERRY, F. W.	32 East Mount Road, York.
1899 Oct. 21	PALMER, G. F.	21 Lester Road, Chatham.
1901 Feb. 6	PALMER, W. L. F...	18 Priory Road, Upper Knowle, Bristol.
1900 June 16	PERCIVAL, W.	Borough Engineer's Office, Longton, Staffs.
1896 Feb. 22	PERKINS, T. L., A.M. Inst.C.E.	4 Linzee Road, Hornsey, N.
1901 Aug. 24	PICKIN, W. H.	Fletton Spring, Peterborough.
1899 Oct. 21	PLANT, W.	Borough Engineer's Office, Leicester.
1888 Sept, 15	PRITCHARD, T., A.M.Inst.C.E.	264 Gresham House, Old Broad Street, E.C.
1898 June 30	QUICK, A. H...	15 Fernholme Road, Newlands, S.E.
1900 Dec. 15	RAWSTRON, C. O.	29B High Street, Rotherham.
1901 June 8	READ, F...	Town Hall, Leyton, N.E.
1899 Mar. 25	RICHARDS, E. P.	Borough Engineer's Office, Southend-on-Sea.
1901 Aug. 24	RILEY, J.	Avondale House, Orchard Road, Erdington, Birmingham.
1899 June 29	ROSE, J. G.	12 Joannah Street, Sunderland.
1900 Feb. 10	ROSS, D.	Brede, Sussex.
1901 Feb. 16	ROTHERA, A.	6 Bolton Road, Pendleton, near Manchester.
1900 June 16	ROUSELL, A. J.	Borough Engineer's Office, Worthing, Sussex.
1901 Aug. 24	ROYLE, F. M...	3rd Avenue, Sherwood Rise, Nottingham.
1894 Oct. 20	SAVAGE, E. B., A.M.Inst. C.E.	City Engineer's Office, Birmingham.
1899 June 29	SIMMS, F.	Town Hall, Sheffield.
1898 Jan. 15	SMITH, G. H.	1 Worcester Road, Wimbledon, S.W.
1898 June 30	SPINK, J.	City Surveyor's Office, Manchester.
1899 June 29	STANTON, F. W. S.	c/o J. Mansergh, Esq., 5 Victoria Street, S.W.

Date of Election.		
1898 June 30	SUTTON, W. F.	Water Department, Broad Street, Birmingham.
1900 Dec. 15	TAYLOR, H. T.	11 Chatham Road, Rockferry, Birkenhead.
1898 Dec. 17	TAYLOR, J.	Town Hall, Bradford.
1900 Dec. 15	TAYLOR, P.	Council Offices, Ilford, Essex.
1895 Jan. 19	THACKERAY, F.	43 Richmond Terrace, Darwen.
1899 June 10	THACKERAY, J. R.	Borough Engineer's Office, Eastbourne.
1898 June 30	TIFFIN, T. E...	York Road South, West Hartlepool.
1900 June 16	TREMELLING, H.	Borough Engineer's Office, Newport, Mon.
1900 Oct. 13	TOMPKINS, H...	6 Ethel Street, Wells, Somerset.
1900 June 16	TOWNER, H. V.	Adelphi Hotel, Singapore.
1899 Oct. 21	TWAITES, J.	Town Hall, Mile End, E.
1893 June 24	VIDEAN, H. N.	Assistant Borough Surveyor, Folkestone.
1900 Dec. 15	WALKER, H.	Whyteleafe, Cecil Road, Wealdstone.
1888 Jan. 14	WARD, F. D., A. M. Inst. C.E.	38 High Street, Welshpool.
1900 May 19	WARLOW, W. R.	Nolton House, Windmill Road, Brentford.
1898 Jan. 15	WARREN, A. R.	73 Breakspears Road, St. John's, S.E.
1897 June 19	WEBB, F.	Town Hall, Chelsea.
1899 June 10	WEIR, J. S.	Town Hall, Halifax.
1898 Jan. 15	WELLS, F. B.	Farnborough Cottage, Limpsfield, Surrey.
1901 June 8	WHITEFORD, E. H.	Municipal Buildings, Plymouth.
1898 Dec. 17	WHITWORTH, W.	Cradley Heath, Staffs.
1901 June 27	WILLETT, A. J.	24a Tremaine Road, Anerley, S.E.
1901 Aug. 24	WILKINSON, H. F...	Fulford House, The Crescent, South Tottenham, N.
1895 June 27	WILLIAMS, D. S.	Hopes Green Road, South Benfleet, Essex.
1901 Dec. 7	WILLIAMS, J. H.	23 Lebanon Street, Burnley.
1900 Dec. 15	WILLS, A. J.	"Hollingworth," Gerald Road, Lansdowne Park, Bournemouth.
1901 Aug. 19	WILSON, H. B.	Town Hall, Wood Green, N.
1900 May 19	WOLFENDEN, B. J.	Borough Engineer's Office, Middlesbrough.
1900 July 19	WRACK, W. P.	117 High Street, Poplar, E.
1901 June 8	YELLAND, T.	Town Hall, Leigh, Lancs.

PARLIAMENTARY AND GENERAL PURPOSES COMMITTEE.

J. P. Barber (Islington), *Chairman.*

J. W. Cockrill (Great Yarmouth).
A. D. Greatorex (West Bromwich).
W. Harpur (Cardiff).
Chas. Jones (Ealing).
J. Lemon (Southampton).
E. G. Mawbey (Leicester).
J. Price (Birmingham).
O. C. Robson (Willesden).
H. T. Wakelam (Westminster).
W. Weaver (Kensington).
T. H. Yabbicom (Bristol).

FINANCE COMMITTEE.

W. Weaver (Kensington), *Chairman.*

J. P. Barber (Islington).
W. Harpur (Cardiff).
C. Jones (Ealing).
J. S. Pickering (Nuneaton).
T. H. Yabbicom (Bristol).

Memorandum of Association

OF

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

1. The name of the Association is "THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS."

2. The Registered Office of the Association will be situated in England.

3. The objects for which the Association is established are:

(a) The promotion of the science and practice of engineering applied to the health and improvement of counties and towns, and rural districts.

(b) The promotion of the professional interests, rights, powers, and privileges of county, urban and rural engineers, the improvement of their professional status, and the extension and interchange of professional knowledge and practice.

(c) The acceptance of any gift, endowment or bequest, made to the Association, and the carrying out of any trusts attached to any such gift, endowment or bequest.

(d) The examination of persons in engineering, surveying, building construction, sanitary science and works, and in local government, municipal and sanitary law; and the granting of certificates of having passed the examination in the above subjects to candidates. Provided that no such certificate be granted without a note on it stating that "This Certificate shows the result of an Examination held on behalf of the Association, and is not to be deemed a qualification to discharge the duties of any office or appointment."

3. (e) The constitution of two classes of members, viz.:—Members and Graduates; and, when thought proper, the election of persons distinguished in connection with Municipal Engineering or in Sanitary Science, as Honorary Members.

(f) Subject to the provisions of the 21st section of The Companies Act of 1862, the acquisition and disposal of lands and property for the objects aforesaid.

(g) The doing all such lawful things as are incidental or conducive to the attainment of the above objects.

4. The income and property of the Association, whencesoever derived, shall be applied solely towards the promotion of the objects of the Association as set forth in this Memorandum of Association; and no portion thereof shall be paid or transferred, directly or indirectly, by way of dividend, bonus, or otherwise howsoever, by way of profit to the Members of the Association. Provided that nothing herein shall prevent the payment in good faith, of remuneration to any officers or servants of the Association, or to any Member of the Association, or other person, in return for any services actually rendered to the Association.

5. The fourth paragraph of this Memorandum is a condition on which a Licence is granted by the Board of Trade to the Association, in pursuance of section 23 of the Companies Act, 1867.

6. If any Member of the Association pays or receives any dividend, bonus or other profit, in contravention of the terms of the fourth paragraph of this Memorandum, his liability shall be unlimited.

7. Every Member of the Association undertakes to contribute to the Assets of the Association, in the event of the same being wound up during the time that he is a Member, or within one year afterwards, for payment of the debts and liabilities of the Association contracted before the time at which he ceases to be a Member, and of the costs, charges and expenses of winding up the same, and for the adjustment of the rights of the contributories amongst themselves, such amount as may be required, not exceeding one pound, or in case of his liability becoming unlimited, such other amount as may be required in pursuance of the last preceding paragraph of this Memorandum.

8. If upon the winding up or dissolution of the Association there remains after the satisfaction of all its debts and liabilities, any property whatsoever, the same shall not be paid to or distri-

buted among the Members of the Association, but shall be given or transferred to some other institution or institutions having objects similar to the objects of the Association, to be determined by the Members of the Association at or before the time of dissolution, or in default thereof by such Judge of the High Court of Justice as may have or acquire jurisdiction in the matter.

9. True accounts shall be kept of the sums of money received and expended by the Association and the matter in respect of which such receipt and expenditure takes place, and of the property, credits and liabilities of the Association; and, subject to any reasonable restrictions as to the time and manner of inspecting the same that may be imposed in accordance with the regulations of the Association for the time being, shall be open to the inspection of the Members. Once at least in every year the accounts of the Association shall be examined, and the correctness of the Balance Sheet ascertained, by one or more properly qualified Auditor or Auditors.

We, the several persons whose names are subscribed are desirous of being formed into an Association in pursuance of this Memorandum of Association.

NAMES, ADDRESSES, AND DESCRIPTIONS OF SUBSCRIBERS.

H. PERCY BOULNOIS, M. Inst. CE., City Engineer, Liverpool.
E. PRITCHARD, M. Inst. C.E., Birmingham.
E. R. S. ESCOTT, M. Inst. C.E., Borough Surveyor, Halifax.
T. DE COURCY MEADE, A. M. Inst. C.E., Surveyor to the Local Board, Hornsey.
W. SANTO CRIMP, A. M. Inst. C. E., District Engineer, London County Council.
A. W. PARRY, A. M. Inst. C.E., Borough Surveyor, Reading.
T. WALKER, A. M. Inst. C.E., Borough Surveyor, Croydon.

Dated the 13th day of September, 1890.

Witness to the above signatures,

THOMAS COLE, A. M. Inst. C.E.
Secretary.

11 Victoria Street,
London, S.W.

Articles of Association

OF

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

INTRODUCTION.

WHEREAS an Association, called the "Association of Municipal and Sanitary Engineers and Surveyors" (hereinafter referred to as the "existing Association"), has long existed for objects similar in many respects to the objects expressed in the Memorandum of the Association to which these Articles apply (hereinafter called "the Association"), and the existing Association consists of Members, Graduates and Honorary Members, and is possessed of Books, Drawings and Property used for the objects aforesaid;

AND WHEREAS the Association is formed for furthering and extending the objects of the existing Association, by a registered Association, under the Companies' Acts 1862 to 1866; and terms used in these Articles are intended to have the same respective meanings as they have when used in those Acts, and words implying the singular number are intended to include the plural number and vice versâ;

Now therefore it is hereby agreed as follows:

CONSTITUTION.

1. For the purpose of registration, the number of Members of the Association is declared to be five hundred, but the Council may at any time register an increase of Members as occasion shall require.

Members.

2. The Subscribers of the Memorandum of Association, and such other persons as shall be admitted in accordance with these Articles, and none others, shall be Members of the Association, and be entered on the Register as such.

3. Any person may become a Member of the Association who, being a Member of the existing Association, shall agree to transfer his Membership of the existing Association, and all rights and obligations incidental thereto, to the Association, and to be registered as a Member of the Association accordingly.

4. Any person may become a Member of the Association who shall be qualified and elected, as hereinafter mentioned, and shall agree to become such Member, and shall pay the entrance fee and first subscription accordingly.

5. The rights and privileges of every Member of the Association shall be personal to himself, and shall not be transferable or transmissible by his own act or by operation of law.

Qualification and Election of Members.

6. The qualification of Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

7. The election of Members shall be conducted as prescribed by the Bye-laws from time to time in force, as provided by the Articles.

Associates, Graduates and Honorary Members.

8. Any person may become an Honorary Member or Graduate of the Association who, being already an Honorary Member or Graduate of the existing Association, shall agree to transfer his interest in the existing Association, and all rights and obligations incidental thereto, to the Association.

9. The Association may admit such other persons as may be hereafter qualified and elected in that behalf as Associates, Graduates and Honorary Members respectively of the Association, and may confer upon them such privileges as shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

10. The qualification and mode of election of Associates, Graduates and Honorary Members shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles.

10A. No Associate, Graduate or Honorary Member shall be deemed to be a Member within the meaning of these Articles,

Entrance Fees and Subscriptions.

11. The Entrance Fees and Subscriptions of Members, Associates and Graduates shall be prescribed by the Bye-laws from time to time in force, as provided by the Articles; and the form of request for admission to the class of Members, Associates or Graduates shall contain a reference to such Subscriptions. Provided that no Entrance Fee shall be payable by a Member or Graduate of the existing Association.

Expulsion.

12. If any Member, Associate or Graduate shall leave his subscription in arrear for two years, and shall fail to pay such arrears within three months after a written application has been sent to him by the Secretary, his name may be struck off the List of Members, Associates or Graduates, as the case may be, by the Council at any time afterwards, and he shall thereupon cease to have any rights as a Member, Associate or Graduate, but he shall nevertheless continue liable to pay the arrears of subscription due at the time of his name being so struck off:

Provided always that this regulation shall not be construed to compel the Council to remove any name if they shall be satisfied the same may be retained.

13. The Council may refuse to continue to receive the subscriptions of any person who shall have wilfully acted in contravention of the lawful regulations of the Association, or who shall in the opinion of the Council have been guilty of such conduct as shall have rendered him unfit to continue to belong to the Association, and may remove his name from the List of Members, Associates, Graduates, or Honorary Members (as the case may be), and such person shall thereupon cease to be a Member, Associate or Graduate (as the case may be) of the Association. Provided that notice shall be given to the offending person, and opportunity of explanation given to him, before his name is removed from the aforesaid List.

General Meetings.

14. The first General Meeting shall be held on such day within four months of the Registration of the Association as the Council shall determine. Subsequent Meetings shall consist of the Annual General Meeting and Special Meetings as hereinafter defined.

15. The Annual General Meeting shall take place in June or July of every year, at such place as the Council shall determine.

16. A Special Meeting may be convened at any time by the Council, and shall be convened by the Secretary whenever a requisition signed by twenty Members of the Association, specifying the object of the Meeting, is left with the Secretary.

If for fourteen days after the delivery of such requisition a Meeting be not convened in accordance therewith, the Requisitionists or any twenty Members of the Association may convene a Special Meeting in accordance with the requisition. All Special Meetings shall, unless otherwise determined by the Council, be held in London.

17. At least seven clear days' notice of every Meeting, specifying generally the nature of any special business to be transacted at any Meeting, shall be given to every Member of the Association, and no other special business shall be transacted at such Meeting; but the non-receipt of such notice shall not invalidate the proceedings of such Meeting. No notice of the business to be transacted (other than such Ballot Lists as may be requisite in case of Elections) shall be required in the absence of special business.

18. Special business shall include all business for transaction at a Special Meeting, and all business for transaction at every other Meeting, with the exception of the reading and confirmation of the Minutes of the previous Meeting, the election of Members, Associates and Graduates, and the reading and discussion of communications as prescribed by the Bye-laws, or any regulations of the Council made in accordance with the Bye-laws.

Proceedings at General Meetings.

19. Thirty Members shall constitute a Quorum for the purpose of a Meeting of the Association.

20. If within thirty minutes after the time fixed for holding the Meeting, a Quorum is not present, no Meeting shall be held, and all matters which might, if a Quorum had been present, have been done at a Meeting (other than a Special Meeting) so dissolved, may forthwith be done on behalf of the Meeting by the Council.

21. The President shall be Chairman at every Meeting, and in his absence one of the Vice-Presidents; and in the absence of all Vice-Presidents a Past President or a Member of the Council shall

take the Chair; and if no Past President or Member of Council be present and willing to take the Chair, the Meeting shall elect a Chairman.

22. The decision of a Meeting shall be ascertained by show of hands, unless, after the show of hands, a poll is forthwith demanded, and by a poll when a poll is thus demanded. The manner of taking a show of hands or a poll shall be in the discretion of the Chairman, and an entry in the Minutes, signed by the Chairman, shall be sufficient evidence of the decision of the Meeting. Each Member shall have one vote and no more. In case of equality of votes the Chairman shall have a second or casting vote, provided that this Article shall not interfere with the provisions of the Bye-laws as to election by ballot.

23. The acceptance or rejection of votes by the Chairman shall be conclusive for the purpose of the decision of the matter in respect of which the votes are tendered, provided that the Chairman may review his decision at the same Meeting if any error be then pointed out to him.

Bye-Laws.

24. The Bye-laws set forth in the Schedule to these Articles, and such altered and additional Bye-laws as shall be added or substituted as hereinafter mentioned, shall regulate all matters by the Articles left to be prescribed by the Bye-laws, and all matters which, consistently with the Articles, shall be made the subject of Bye-laws. Alterations in, and additions to, the Bye-laws, may be made only by resolution of the Members at an Annual General Meeting, on the recommendation of the Council, or after notice of motion for such purpose, and the general tenor of the proposed resolution thereon has been sent to the Secretary on or before the 1st of May preceding the date of the Annual General Meeting, and such recommendation or notice of motion and resolution shall be printed in the Agenda for the ensuing Annual General Meeting:

Provided that no regulation shall be made or altered by a Bye-law which, if any, could only be legally imposed by Article of Association, or added or altered by a Special Resolution.

Council.

25. The affairs of the Association shall be governed by a Council who shall be chosen from the Members only, and shall

consist of one President, three Vice-Presidents, fifteen Ordinary Members of Council, Honorary Secretary, Honorary Treasurer, six Past-Presidents, and the District Honorary Secretaries for the time being.

26. The President, Vice-Presidents, Ordinary Members of the Council and one Past-President who is an elective Member of Council, shall retire at each Annual General Meeting, but shall be eligible for re-election.

27. The election of a President, Vice-Presidents and Members of the Council, including Past-Presidents who are elective Members thereof, shall be conducted in such manner as shall be prescribed by the Bye-laws from time to time in force.

28. The Council may supply any casual vacancy in the Council (including any casual vacancy in the office of President) which shall occur between one Annual General Meeting and another, and the President or Members of the Council so appointed by the Council shall retire at the succeeding Annual General Meeting. Vacancies not filled up at any such Meeting shall be deemed to be casual vacancies within the meaning of this Article.

Officers.

29. The Secretary, Officers and Servants of the Association shall be appointed and removed in the manner prescribed by the Bye-laws from time to time in force, as provided by the Articles. Subject to the express provisions of the Bye-laws, the Secretary, Officers and Servants of the Association shall be appointed and removed by the Council.

30. The powers and duties of the Secretary and Officers of the Association shall (subject to any express provision in the Bye-laws) be determined by the Council.

Powers and Procedure of Council.

31. The Council may regulate their own procedure, and delegate any of their powers and discretion to any one or more of their body, and may determine their own quorum. If no other number is prescribed, three Members of Council shall form a quorum.

32. The property of the existing Association shall be acquired by the Association, and the Council shall manage and administer the property, proceedings and affairs of the Association, in accordance with the Bye-laws from time to time in force.

33. The Council may from time to time invest, in the name of the Association, any moneys not immediately required for the purposes of the Association, in Stocks, Funds, or Securities in which Trustees are by law for the time being authorised to invest.

34. No act done by the Council, which shall receive the express or implied sanction of the Members of the Association in General Meeting, shall be afterwards impeached by any Member of the Association on any ground whatsoever, but shall be deemed to be an act of the Association.

District Committees.

35. District Committees of the Association may be formed, and District Secretaries appointed, in accordance with the Bye-laws for the time being of the Association, and there shall be referred to such Committees all such local or other business and matters as the Bye-laws for the time being shall prescribe, or as may be specially referred to them or any of them by the Council; but the acts and Resolutions of the District Committees shall not be binding upon the Association unless approved of by the Council. Ten Members shall constitute a Quorum of a District Committee.

Examinations.

36. The Council may hold Examinations of persons in Engineering, Surveying, Building Construction, Sanitary Science and Works, and in Local Government, Municipal and Sanitary Law, in accordance with the Bye-laws for the time being of the Association, and they may grant Certificates of competency in the above subjects to Candidates.

Notices.

37. A notice may be served by the Council of the Association upon any Member, Associate, Graduate, or Honorary Member, either personally or by sending it through the post in a prepaid letter addressed to such Member, Associate, Graduate, or Honorary Member, at his registered place of abode.

38. Any notice, if served by post, shall be deemed to have been served at the time when the letter containing the same would be delivered in the ordinary course of the post, and in proving such service it shall be sufficient to prove that the letter containing the notice was properly addressed, and put into the post office.

39. No Member, Associate, Graduate, or Honorary Member, not having a registered address within the United Kingdom, shall be entitled to any notice; and all proceedings may be had and taken without notice to such Member in the same manner as if he had had due notice.

NAMES, ADDRESSES AND DESCRIPTIONS OF SUBSCRIBERS.

H. PERCY BOULNOIS, M. Inst. C.E., City Engineer, Liverpool.
E. PRITCHARD, M. Inst. C.E., Birmingham.
E. R. S. ESCOTT, M. Inst. C.E., Borough Surveyor, Halifax.
T. DE COURCY MEADE, A. M. Inst. C.E., Surveyor to the Local Board, Hornsey.
W. SANTO CRIMP, A. M. Inst. C.E., District Engineer, London County Council.
A. W. PARRY, A. M. Inst. C.E., Borough Surveyor, Reading.
T. WALKER, M. Inst. C. E., Borough Surveyor, Croydon.

Dated the 13th day of September, 1890.

Witness to the above signatures,

THOMAS COLE, A. M. Inst. C. E.
Secretary.

11 Victoria Street,
London, S.W.

SCHEDULE

BYE-LAWS.

Membership.

1. Members, Graduates and Honorary Members ot the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates or Honorary Members respectively of the Association, without election or payment of entrance fees.

Members.

2. Members shall comprise every person who on the 1st May, 1902, was registered as a Member; and every person thereafter elected or transferred to the class of Members. Every Candidate for election or transfer to the class of Members shall be not less than twenty-five years of age, and shall come within the following conditions:

(a) He shall have undergone a recognised course of instruction for a Civil Engineer and Surveyor, and shall hold a chief permanent appointment under a Municipal Corporation, County Council, Urban or Rural District Council, or a Public Authority of the like nature.

(b) He shall also have passed the examination of the Incorporated Association of Municipal and County Engineers, or he shall be a Member or an Associate Member of the Institution of Civil Engineers, or shall have passed the examination for the Associate Membership of the Institution of Civil Engineers, or shall hold such a degree or diploma in Engineering from an University or other Educational Body, or shall possess such other engineering qualifications as, in the opinion of the Council of the Association, are deemed equivalent to one of the beforementioned qualifications.

Associates.

2a. Every Candidate for election to the class of Associates shall be not less than twenty-five years of age, and shall come within the following conditions:—

(*a*) He shall have undergone a recognised course of instruction for a Civil Engineer and Surveyor, and shall hold a permanent position of importance under a Municipal Corporation, County Council, Urban or Rural District Council, or a Public Authority of the like nature.

(*b*) He shall also have passed the examination of the Incorporated Association of Municipal and County Engineers, or he shall be a Member or an Associate Member of the Institution of Civil Engineers, or shall have passed the examination for the Associate Membership of the Institution of Civil Engineers, or shall hold such a degree or diploma in Engineering from an University or other Educational Body, or shall possess such other Engineering qualifications as, in the opinion of the Council of the Association, are deemed equivalent to one of the before-mentioned qualifications.

No person shall be elected or remain an Associate who shall be qualified for election as a Member.

Graduates.

3. Every Candidate for election to the class of Graduates shall be not less than twenty-two years of age, and shall have passed the examination of the Incorporated Association of Municipal and County Engineers.

No person shall be elected or remain a Graduate who shall be qualified for election as a Member or an Associate.

Honorary Members.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

Members, Associates, Honorary Members and Graduates.

5. Members, Associates, Honorary Members and Graduates shall be entitled to attend all Meetings of the Association, to take part in the proceedings thereof, and to receive a copy of the Minutes of Proceedings; but no Associate, Honorary Member or Graduate shall be entitled to vote, to hold any office, or to be a Member of the Council.

5A. Any Member or Associate ceasing to hold a permanent appointment or position of the nature described in Bye-laws 2 and 2A, as the case may be, shall cease to belong to the Association, but may be re-elected by the Council. No Member so re-elected shall be a Member of the Council or hold any Office in the Association other than that of Hon. Secretary or Hon. Treasurer.

Entrance Fees and Subscriptions.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. An Associate who shall have passed the examination of the Association shall not be required to pay an Entrance Fee, but otherwise he shall pay an Entrance Fee of One Guinea. An Associate or Graduate shall not be required to pay an Entrance Fee on his becoming a Member, nor a Graduate on his becoming an Associate. Each Associate shall pay an Annual Subscription of Fifteen Shillings, and each Graduate shall pay an Annual Subscription of Half a Guinea.

8. Entrance Fees shall be paid within one month after notification of election has been given to the persons from whom they are due. All Subscriptions shall be payable in advance, and shall become due on the 1st of May in each year. Members, Associates and Graduates elected between the 1st day of November and the 1st day of May next ensuing, shall pay the Entrance Fees as aforesaid, but their first Subscription shall not become due until the 1st day of May following their election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the

Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Ballot List shall be sent to any Member who shall be in arrear with his Subscription more than twelve months, and no Minutes of Proceedings shall be sent to any Member, Associate or Graduate so in arrear, and no such Member, Associate or Graduate shall be entitled to attend any Meeting of the Institution. Provided that this rule shall not apply to any Member whose Subscriptions shall have been remitted by the Council as hereinbefore provided.

Election of Members, Associates and Graduates.

11. A recommendation for admission according to Form A for a Member, Form A 1 for an Associate, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside the United Kingdom not known by two Members of the Association, may be proposed by three Corporate Members of the Institution of Civil Engineers.

All elections of Members, Associates and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members, Associates or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-laws.

Transfer of Associates and Graduates.

13. A qualified Associate or Graduate desirous of becoming a Member shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E.

13A. A qualified Graduate desirous of becoming an Associate shall forward to the Secretary a recommendation according to Form D[1] in the Appendix, signed by not less than two Members, which shall be laid before the next Meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E.

Election of President, Vice-Presidents, and Members of Council.

14. The Council shall nominate one name for President, three for Vice-Presidents, one for Honorary Secretary, one for Honorary Treasurer and eighteen for Ordinary Members of Council. In addition to these each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the nominations by Members of the Association exceeding twelve the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Should the Members of the Association not exercise their privilege of nominating twelve names, then the Council may increase the number of their nominations for ordinary Members of Council, providing the total nominations do not exceed thirty in all. Members' nominations must be received by the Secretary not later than the 1st of February in each year. The names of those nominated shall be printed on Ballot Papers, one of which shall be sent to each Member of the Association entitled thereto not less than fourteen days previous to the Annual Meeting. Each Member receiving a Ballot Paper shall be entitled to vote for or erase any of the names thereon and to substitute others, subject in all cases to the limits of Clause 25 in the Articles of Association; such Ballot Paper must be returned to the Secretary and received by him not later than seven days from the date of issue. The returned Ballot Papers shall be examined at the Offices of the Association by the President, Secretaries and two Scrutineers appointed at the previous Annual Meeting.

A Past-President shall be ex-officio a Member of the Council during the three years next after the date of his ceasing to be President.

There shall also be three other Past-Presidents elected by ballot by the Council as Members of Council. Such Past-Presidents shall

be Members of Council for three years, and one shall retire each year. The election of a Past-President to fill the place of the retiring Past-President shall take place annually at the meeting of the Council in April. At the first election one of such Past-Presidents shall be elected a Member of Council for one year only, one for two years only, and one for three years.

Any Member of the Association canvassing for votes for the office of Member of Council shall be ineligible for election.

Appointment and Duties of Officers.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President); to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

Examinations.

18. Two or more examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and Municipal Law, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be not less than twelve in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four or more of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

Miscellaneous.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

22. No Member, Associate or Graduate shall use the initial letters of the name, or any abbreviation of the name, of the Association to indicate his connection therewith.

APPENDIX.

Form A.

THE INCORPORATED ASSOCIATION OF MUNIPICAL AND COUNTY ENGINEERS.

To the Council of the Association.

I hereby request to be enrolled as a Member of The Incorporated Association of Municipal and County Engineers, and, if so enrolled, I do hereby undertake to abide by the Rules of the Association, and to pay the Annual Subscription prescribed by the Bye-laws and Articles for the time being in force.

Witness my hand this__________day of__________19____

*Signature*____________________

*Name in full*____________________

*Address*____________________

*Town or District represented*____________________

Qualification, Bye-law 2____________________

We, the undersigned, from our personal knowledge, propose and recommend the above named____________________as possessing the qualification necessary to become a Member of the Association.

____________________ *Signature of at least Two Members*
____________________ *of the Association are required for the proposal of a Member.*

Form A[1].

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

I hereby request to be enrolled as an Associate of The Incorporated Association of Municipal and County Engineers, and, if so enrolled, I do hereby undertake to abide by the Rules of the Association, and to pay the Annual Subscription prescribed by the Bye-laws and Articles for the time being in force.

Witness my hand this__________day of__________19____

*Signature*____________________

*Name in full*____________________

*Address*____________________

*Town or District represented*____________________

Qualification, Bye-law 2a____________________

We, the undersigned, from our personal knowledge, propose and recommend the above named____________________as possessing the qualifications necessary to become an Associate of the Association.

____________________ *Signature of at least Two Members*
____________________ *of the Association are required for the proposal of an Associate.*

Form B.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

Having passed the Examination and holding the Certificate of Competency, I hereby request to be enrolled as a Graduate of the Incorporated Association of Municipal and County Engineers, and, if so enrolled, I do hereby undertake to abide by the Rules of the Association.

Witness my hand this__________day of__________19___

*Signature*____________________

*Name in full*____________________

*Address in full*____________________

*Date of Certificate*____________________

We, the undersigned, from our personal knowledge, propose and recommend the above named__________________as possessing the qualifications necessary to become a Graduate of the Association.

____
____________________ } *Signatures of at least Two Members of the Association are required for the proposal of a Graduate.*

Form C.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

SIR,

I have to inform you that at a Council Meeting held on the__________day of__________19___you were elected__________ of the Incorporated Association of Municipal and County Engineers.

I am, sir,

Your obedient servant,

____

Secretary.

Forms D and D[1].

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

To the Council of the Association.

Being duly qualified according to Bye-law $\frac{2,}{2a,}$ I hereby request to be transferred from the class of $\frac{\text{Graduate}}{\text{Associate}}$ to that of $\frac{\text{Member}}{\text{Associate}}$ of the Incorporated Association of Municipal and County Engineers, and, if so transferred, I do hereby undertake to abide by the Rules of the Association, and to pay the Annual Subscription prescribed by the Bye-laws and Articles for the time being in force.

Witness my hand this__________day of___________19

*Signature*________________________________

Name in full ________________________________

*Address*________________________________

*Town or District represented*________________________

Qualifications, Bye-law $\frac{2}{2a}$ ________________________

We, the undersigned, from our personal knowledge, propose and recommend the above named__________________ as possessing the qualifications necessary to become $\frac{\text{a Member}}{\text{an Associate}}$ of the Association.

____

____

Signatures of at least Two Members of the Association are required for the proposal of $\frac{\textit{a Member.}}{\textit{an Associate.}}$

Form E.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

Sir,

I have to inform you that at a Council Meeting held on the __________day of_____________19____you were transferred from the class of ________ to that of ________ of this Association.

I am, sir,

Your obedient servant,

____

Secretary.

Form F.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

Address ______________________________

Date ______________________________

As a [*Member*, *Graduate*, or *Honorary Member*] of the Association of Municipal and Sanitary Engineers and Surveyors, I claim to become a [*Member*, *Graduate*, or *Honorary Member*] of the Incorporated Association of Municipal and County Engineers. And I hereby agree to transfer my Membership in the Association of Municipal and Sanitary Engineers and Surveyors and all rights and obligations incidental thereto to the Incorporated Association of Municipal and County Engineers.

Please to register my name accordingly.

Signature ______________________________

To

THE SECRETARY

of the Incorporated Association of

Municipal and County Engineers.

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

TWENTY-EIGHTH ANNUAL MEETING.

LEICESTER, *June* 27, 28, *and* 29, 1901.

THE Members assembled in the Council Chamber, Town Hall, Leicester, the use of which had been kindly granted by the Mayor and Corporation.

The Mayor of Leicester (Mr. Alderman S. Lennard, J.P.) opened the proceedings by offering to the Association a very hearty welcome to Leicester.

The President, Mr. C. H. Lowe, on behalf of the Association, thanked the Mayor for the kind welcome offered them.

The Secretary read the Minutes of the last Annual General Meeting, which were confirmed and signed.

The Secretary read the Council's Annual Report.

ANNUAL REPORT.

In presenting the Report of the proceedings of the past year, the Council have much satisfaction in stating that the progress of the Association is well maintained.

DISTRICT MEETINGS.

Six District Meetings have been held: At Tonbridge, September 14; at Deal, September 15; at East Molesey and

Hampton, October 6, 1900; at Wimbledon, March 16; at Oswestry, May 18; and at Chichester, June 1, 1901.

The Roll of the Association.

During the financial year ending April 30 last, 62 New Members, consisting of 40 Ordinary Members and 22 Graduates, have joined the Association; 6 Members have resigned, 11 names have been written off, and the Council record with regret the deaths of Messrs. W. H. Brockbank, A. Comber, W. Santo Crimp, Y. Kurata, T. Martin, T. Nuttall, E. Pritchard, R. B. Sanders, and W. Young.

The number on the Roll of the Association at the close of the year was 10 Honorary Members, 808 Ordinary Members, and 148 Graduates, making a total of 966, being an addition of 3·8 per cent. on the numbers of the preceding year.

The Council have transferred Messrs. J. P. Bennetts, F. C. Cook and F. Lobley from the class of Graduates to that of Members, these gentlemen having been elected to appointments qualifying them for this class under the Articles of Association.

The Finances.

The audited Balance-Sheet and Statement of Accounts which accompany this Report show a balance in hand on April 30 last of 297*l.* 9*s.* 4*d.* The invested capital of the Association now stands at 1189*l.* 3*s.* 9*d.*; 177*l.* 16*s.* having been invested to purchase 200*l.* Metropolitan 2½ per cent. Consolidated Stock during the year. The Statement of Assets and Liabilities shows that the Association continues to be in a thoroughly sound position.

The Examinations.

Since the last Report three examinations have been held—one at Birmingham on September 28 and 29, 1900, when 19 candidates presented themselves for examination. Of these 13 satisfied the examiners and were granted their certificates. The examiners were Messrs. Angell, Collins, Eayrs, Lemon and Price.

The second examination was held in London on April 19

and 20, 1901, when 23 candidates presented themselves, of whom 15 satisfied the examiners and were granted their certificates. The examiners were Messrs. Angell, Collins, Eayrs and Price.

The third examination was held in London on April 26 and 27, 1901, when 22 candidates presented themselves, of whom 15 satisfied the examiners and were granted their certificates. The examiners were Messrs. Fowler, Laws, Lemon and Lobley.

Arrangements were made to hold an examination in Ireland, but owing to an insufficiency of candidates the carrying out of such examination was postponed.

It may be interesting to note that up to the present date 566 candidates have entered for the Association's examinations. Of these 375, or 66 per cent. of the total, have satisfied the examiners.

The New Council.

The ballot lists having been duly issued, the Scrutineers reported the result of the voting as follows:—

President—Mr. E. G. Mawbey.

Vice-Presidents—Messrs. J. Patten Barber, W. Weaver, and T. H. Yabbicom.

Ordinary Members of Council—Messrs. W. N. Blair, A. E. Collins, A. Creer, A. T. Davis, A. D. Greatorex, E. P. Hooley, A. B. MacDonald, J. Paton, S. S. Platt, J. Price, H. T. Wakelam, and C. F. Wike.

Honorary Treasurer—Mr. Lewis Angell.

Honorary Secretary—Mr. Charles Jones.

Superannuation.

The Local Authorities Officers' Superannuation Bill was re-introduced in the House of Commons and read a first time, in March last.

Your Council thereupon addressed a circular to every

Member of the Association, urging the importance of at once invoking the interest of his local member in Parliament in support of the measure during its progress through the House.

From the numerous replies that have been received it may be hoped that considerable aid has been thus secured from several quarters in furtherance of the Council's earnest endeavours to support this much-required measure.

Glasgow Congress.

This Association has been honoured with the charge of the Municipal Section of the Engineering Congress to be held in Glasgow in September next.

In order that the benefit of such an important gathering should be widely felt, the Council have forwarded to each authority in the kingdom full particulars of the Congress, and have appealed for facilities to be granted to the Authority's Surveyor to attend the Congress.

The request for papers has been very fairly replied to, and the selection of papers to be read and discussed, together with the visits to works which are being arranged for by the Congress authorities, promise a very interesting and successful meeting.

Alterations in Bye-laws, Articles, etc.

The Council have very carefully considered certain resolutions which were carried at the last General Meeting and sent up to them for consideration, as to the desirability of making certain alterations in the Bye-laws, etc., of the Association. Notice of such alterations as seem to the Council desirable has been given by Mr. Barber, in accordance with the requirements of Article 24, and the alterations are set out on the Agenda for the present meeting. As regards the Articles of Association, the required alterations duly set forth will be submitted to a Special General Meeting in connection with this meeting, and, if passed by a three-quarters majority, have to be confirmed by a subsequent meeting in accordance with the requirements of the Companies' Acts.

New Model Bye-laws for Rural District Councils.

The Council have under their consideration the draft Bye-laws of the Local Government Board.

The Council have been given to understand that the Bye-laws that are about to be issued by the Local Government Board are to be considered tentative only, and that after a certain period their practical working will be tested, and any suggestions sent in by this Association, or by the authorities interested, will be carefully considered by the Board before issuing a revised set of the Bye-laws.

The Orphan Fund.

Since the last Report this fund has made satisfactory progress. The Council, however, urge upon the Members generally the necessity of supporting so very desirable and useful a fund.

Conclusion.

In concluding their Report, the Council desire to place upon record their sense of deep obligation to the individual Members of the Committees which have during the past year so well carried out the arduous duties imposed upon them, thereby materially assisting the work of the Council.

Chas. Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

On the motion of the President, seconded by Mr. R. A. MacBrair, the Report was received and adopted.

It having been moved and seconded, it was agreed that the various District Secretaries continue in office till the next meeting in their respective districts.

Messrs. W. H. Savage and S. Stallard were re-elected Auditors for the ensuing year.

Messrs. H. J. Clarson, E. J. Silcock and F. S. Yates were re-elected Scrutineers for the ensuing year.

Mr. Lowe, the retiring President, then introduced his successor, Mr. E. George Mawbey, and vacated the chair in his favour.

A vote of thanks to the retiring President was proposed by Mr. F. J. C. May, seconded by Mr. T. H. Yabbicom, and carried with acclamation.

Mr. Lowe having acknowledged the vote,

Mr. Mawbey then read his Inaugural Address,* a hearty vote of thanks for which was proposed by Mr. J. Lobley, duly seconded and carried.

The following Papers were read and discussed:—

"Permanent Way Construction for Electric Traction," by W. H. Smith. "Methods of Safety for the Overhead Electric Trolley System," by E. Manville. "Points as to Wear on Roads caused respectively by Horse Haulage and Motor Traffic," by W. W. Beaumont. "Experiments with Stoddart's Sewage Filter," by T. H. Yabbicom. "Rifle Ranges, and their Public Provision," by J. W. Bradley. "Liabilities of Local Authorities under 38 & 39 Vict. cap. 55, Sec. 24," by F. W. Mager. "Asylums, or Homes for the Insane," by J. V. Edwards.

Votes of thanks were accorded to the Authors of the papers, to the Mayor and Corporation of Leicester for the use of the rooms in the Town Hall, and to the President, Mr. E. G. Mawbey.

At the close of the proceedings, the Meeting proceeded to consider certain proposed alterations and additions to the Bye-laws as set forth on the agenda for the Meeting. These were all carried.

* This Address and the Papers read at the Meeting will be found at the end of the volume.

The meeting was then made special, and certain alterations in and additions to the Articles of Association were considered and passed.

In accordance with the Companies Acts 1862 to 1890, these alterations and additions to the Articles of Association were confirmed at a special meeting duly convened and held at the Westminster Palace Hotel, Victoria Street, London, S.W., on July 24, 1901.

The Articles of Association and Bye-laws, altered as above, are printed in the first portion of this volume.

RECEIPTS.	£	s.	d.
To Balance, May 1, 1900	87	5	10
„ Entrance Fees	37	16	6
„ Subscriptions	759	13	9
„ New Graduates	11	11	0
„ Subscriptions in advance	18	18	0
„ Arrears	83	9	6
„ Sale of 'Proceedings'	31	9	10
„ Examination Fees	249	18	0
„ Interest on Investments	29	17	9
„ Balance of Petty cash, May 1	6	7	7
£	1316	7	9

STATEMENT OF ASSETS

LIABILITIES.	£	s.	d.
To Estimated Liability on Vol. XXVII.	40	0	0
„ Examiners	80	0	0
„ Sundry Printing, Stationery, &c.	25	0	0
„ Reporting	4	4	0
„ Secretary, for Assistant	10	0	0
„ Sundry Creditors	10	0	0
„ Balance	1406	0	10
£	1575	4	10

Examined and found correct, this

FOR THE YEAR ENDING APRIL 30, 1901. **Cr.**

EXPENDITURE.	£ s. d.	£ s. d.
By Reports of Meetings	..	33 12 0
" Examiners' Fees and Expenses	..	45 6 8
" Auditors' Expenses	..	2 2 0
" Scrutineers' Expenses	..	6 9 3
" Meetings, Expenses	..	11 17 10
" Printing and Stationery	..	52 13 6
" Messrs. Clowes, Vol. XXVI. and other Printing	..	198 16 0
" Messrs. Sprague, Illustrations	..	20 12 6
" Rent of Telephone	..	17 0 0
" Secretary, Salary and Rent	..	300 0 0
" Allowance for Assistant	..	48 0 0
" Travelling Expenses	..	9 6 7
" Bankers' Charges	..	0 12 10
" Premium	..	5 0 0
" Sundries	..	9 11 4
" Petty Cash—		
Postages	35 12 1	
General	16 17 9	
Balance in hand	3 17 9	
		56 7 7
" Purchase of Metropolitan 2½ % Stock	..	177 16 0
" Postage of Volume, Circulars, etc.	..	28 14 4
" Balance at Bank, May 1, 1901	..	297 9 4
	£	1816 7 9

AND LIABILITIES.

ASSETS.	£ s. d.	£ s. d.
By Balance at Bank, May 1, 1901	..	297 9 4
" £490 Southampton Corporation Stock at 96 ..	..	470 8 0
" £260 7*s.* 4*d.* India 2½ % Stock at 86	..	223 18 0
" £261 14*s.* 7*d.* London County Council 2½ % at 84	..	219 15 0
" £200 Metropolitan 2½ % Consolidated, at 85 ..	..	170 0 0
" Subscriptions in Arrear	205 16 0	
Less 50 per cent. bad	102 18 0	
		102 18 0
" 'Proceedings' in Stock	231 6 0	
Less 75 per cent.	173 9 6	
		57 16 6
" Office Furniture	..	33 0 0
	£	1575 4 10

18th *day of June*, 1901.

W. H. Savage, *Auditor*.

Lewis Angell, *Treasurer*.
Chas. Jones, *Hon. Secretary*.
Thomas Cole, *Secretary*.

DISTRICT MEETING AT TONBRIDGE.

September 14, 1900.

Held at the Council Chamber, Tonbridge.

W. WEAVER, M. INST. C.E., VICE-PRESIDENT, *in the Chair.*

THE Chairman of the Council (Mr. W. Baldwin, J.P.) received the Members, offering them a hearty welcome to the town.

Mr. Weaver, on behalf of the Association, thanked the Chairman of the District Council for the kind welcome extended to the Members. He had no doubt their visit would be productive of good to the Members of the Association, and possibly of service to the District Council.

Mr. R. J. Thomas was unanimously re-elected Honorary Secretary for the Home Counties District.

The following papers were then read and discussed.

MUNICIPAL WORK IN TONBRIDGE.

BY WM. LAURENCE BRADLEY, C.E., ENGINEER AND SURVEYOR TO THE URBAN DISTRICT COUNCIL.

TONBRIDGE is an ancient town and large parish about 30 miles south-east from London on the South Eastern Railway; the town is seated in a valley on the banks of the river Medway which is spanned by an iron bridge of three bays on stone piers, and which was rebuilt in 1888 from the designs and under the supervision of Mr. F. W. Ruck, Kent County Surveyor, the river being navigable for barges up to about 60 tons.

Tonbridge was a town of considerable importance in former days, owing to its Castle and fortifications. It is now more of a residential neighbourhood and a market centre for the surrounding district, the principal industries being cricket-ball making, and printing works, two large establishments of the latter kind having been recently started in the town, namely, those of Messrs. Bradbury, Agnew and Co., Limited, and of Messrs. James Truscott and Son, which together (when the works of the latter are completed) will give employment to nearly 1000 hands.

The traffic of the town is very considerable, and very large additions are contemplated by the South Eastern Railway Company in order to cope with it, the proposed expenditure for which will probably be over 100,000*l.*

Another important factor in the town's prosperity is its School, which was founded in 1553 under a charter of King Edward VI., by Sir Andrew Judd, Alderman and Lord Mayor of London, and its management is now vested in the Master and Wardens of the Skinners Company. The buildings comprise a very handsome block built in local sandstone, and are well worth a visit.

The northern portion of the town is on clay and the southern on the Tunbridge Wells sand, and the long narrow stretch of flat land on the south side of the river is alluvium.

The district is supplied with water by the Tonbridge Water Company, whose works lie on the south side of the river within five minutes walk of the Castle, and may be inspected by any of the Members, whom the Engineer and Manager, Mr. Lees, will be pleased to show round. Regular chemical and bacteriological examinations of the water are made by Dr. Tew, the Medical Officer of Health for the district, and the reports point to high quality water.

The town is at present lighted with gas, the High Street with incandescent burners and the other streets with ordinary burners, but a provisional order has been obtained by the Council authorising them to supply electricity for the district; the Local Government Board have sanctioned the purchase of a site on the Castle property, and a report and estimate on the whole question of providing electricity works by Mr. Robert Hammond, M.Inst.E.E., is now under the consideration of the Council.

STATISTICS AND FINANCE.

The town was formerly governed by a Local Board of Health which was formed in 1870, but under the Local Government Act of 1894 is now controlled by an Urban District Council of eighteen Members.

The area of the district is 1200 areas, with about 2850 inhabited houses, and an estimated population at the present time of about 14,000.

A glance at the following table will show how the district has grown during the last few years :—

	Population.	Rateable Value. £
1891	10,117	46,308
1895	—	53,949
1896	—	55,535
1897	—	58,361
1898	—	61,834
1899	—	64,588
1900	14,000	65,273

The Council's indebtedness up to March 31, 1899 was 56,565*l.* and the average district rate for the last few years has been 3*s.* 4*d.* in the pound per annum.

VITAL STATISTICS.

Although in 1895 the town was visited with a sharp epidemic of scarlet fever, it has since been remarkably free from the various infectious diseases, which may be taken as exceedingly satisfactory when we consider the position of the town, part of it being very low-lying and also the fact of its being an important junction and the large number of people passing from one part of the railway station to another, in addition to the annual influx of hop-pickers on their way to the hop gardens.

For the three years ending December 1899 the total number of cases of infectious disease were as follows :—

Scarlet fever	40	Small pox	0
Typhoid fever	20	Erysipelas	29
Diphtheria	11		

A very considerable number of the above cases, particularly

typhoid fever and diphtheria, were imported into the town from other places.

The death-rate for 1899 was 15·4 per thousand, but as this is estimated on a population of 10,839—arrived at by the method adopted by the Registrar-General—it is without doubt very considerably above what it really ought to be.

The death-rate in 1895, which was estimated on a more actual population, was 13·1.

The total average death-rate for the last six years is 13·8.

Street Improvements.

One of the most important and costly works undertaken by the Council is what is known as the High Street Improvement, which has been carried out in pursuance of two provisional orders dated March 1893 and April 1895, and which has probably been noticed by the Members in walking up from the railway station. There is no doubt that the conversion of this wretched street as it existed previous to 1895 to its present condition has tended considerably towards the increased prosperity of the town.

The street has been widened from a width in some places of only 28 feet to an average width of 50 feet, and up to the present time a length of about 800 feet has been completed, and the work of continuing the scheme it still in hand.

Up to the present time, and as far as the road has been widened, the sum paid for the purchase of properties amounts to 25,482*l.* 2*s.* 11*d.*, and a sum of 8156*l.* 10*s.* 5*d.* has been received for the sale of surplus land, making the net cost of the improvement for the purchase of the land 17,325*l.* 12*s.* 6*d.*

The old property pulled down had a rateable value of 533*l.* The new property erected to the new building line has a rateable value of 1944*l.*, showing an increase to our rateable value owing to this scheme alone of 1411*l.*, working out at 3*s.* 4*d.* in the pound (average district rate) at 235*l.* 3*s.* 4*d.*, which, deducted from 690*l.* 14*s.* 4*d.* representing the repayment of principal and interest, leaves a sum of 455*l.* 11*s.* as the net annual loss to the town, and which is only equal to a penny rate each half year—a result which the Members of the Association will no doubt agree with the Author is most satisfactory.

Several minor improvements have also been made in the High Street within the last few years, and when the scheme is carried right through to the Great Bridge, the town will have every reason to be proud of its main thoroughfare.

The cost of making up the extra width of road, kerbing, channelling and paving has been borne by the County.

Another important improvement will shortly be effected by the demolition of the old Town Hall, the ugly building standing in the middle of the street close to the present entrance to the Castle. This, together with the strip of land adjoining the north-west boundary of the Castle property, has been purchased by the Council from Lady Stafford's trustees for the sum of 1471*l.* 10*s.*, and as soon as the present occupier's lease expires (which the Author believes is in 1901), the building will be pulled down and the space thrown into widening the street.

Roads.

At the present time there are 4¾ miles of main roads and 5 miles of district roads which have been dedicated and are repaired by the authority. The main roads up to last year have been repaired with Penlee stone, but numerous complaints having been received as to the dangerous and slippery state of the roads in the winter time, the Council have commenced a trial of Quenast granite, and although its durability is hardly equal to the Penlee stone, the Author is of opinion that it is less slippery. For many years past patent Victoria stone has been used for paving the footpaths in the High Street; and as the improvements are carried out, new 6-inch by 12-inch Norway granite kerb and solid granite slab channelling 18 inches wide is being laid throughout the High Street.

The district or secondary roads and streets are repaired with Sevenoaks stone, a chert which, in the Author's opinion, makes an excellent road where the traffic is not excessive and the cost of the stone is not great.

New Streets.

During the Author's service with the Tonbridge Urban Council, about 4½ miles of new street have been laid out, a large portion having been made up and completed under the

Author's supervision; and a considerable quantity of work of this nature is at present in hand. The Council use one specification for all roads, which comprises briefly the following requirements: For carriageways, 9 inches of Kent rag rubble or hard burnt High Brooms brick rubble, rough rolled with a steam roller and covered with 6 inches of 2-inch broken Sevenoaks stone well blinded and thoroughly steam-rolled to a good surface, the thicknesses of material to measure after consolidation; the kerb to be 6-in. by 12-in Norway granite, laid on edge on 6 inches of cement concrete; the channelling consisting of three or four rows, according to gradient, of 4-inch granite cubes laid on 6 inches of cement concrete well grouted in with cement and sand. The footpaths are paved with a special Hawkenbury red paving brick in sand on a 4-inch foundation of fine brick rubble or clinkers. The gullies principally used are Sykes' patent stoneware. The present cost of a 36-feet road constructed to the above specification, is about 23s. a foot lineal.

SEWERAGE.

The sewerage of the town is carried out entirely on the separate system with regard to road water, and also with regard to roof and yard water excepting a few of the older streets, but wherever the opportunity occurs connections are gradually being made to the surface-water sewers, which discharge into the River Medway or the back streams at different points.

The main sewerage of the town was carried out between 1872 and 1874, the sewage being conveyed by two outfalls, the one known as the northern outfall taking the whole of the sewage from that part of the town lying north of the River Medway, and the southern outfall taking the sewage from that portion lying south of the river; the northern outfall crosses under the River Medway by means of a syphon. The whole of the sewage discharges into receiving tanks at the farm, which is situated about half a mile east of the town.

For some time previous to the Author's present appointment, complaints had been received pointing to the inadequacies of the southern outfall sewer, and to portions of sewers in other parts of the town. Acting on the instructions of the Council the Author made a careful inspection of the sewers, some of which

were found to be in an exceedingly bad condition, many with the falls laid the wrong way, and defective joints—in fact the whole of the sewers had been laid with clay joints, which in many cases applied only to the inverts.

The levels were also such as to cause the greatest difficulty in extending the system to meet the rapidly increasing building, which is going on at the outskirts of the town.

The Author was thereupon instructed to prepare the necessary plans, sections, estimates and so forth, which were in due course laid before the Local Government Board, and sanction to borrow the amount to carry out the work was obtained. The total sum spent amounted to nearly 7000*l.*, the whole of the work being carried out without the assistance of a contractor, with the exception of the Shone Pneumatic Ejectors, and the air and rising mains, which were supplied and fixed by Messrs. Hughes and Lancaster. The amount sanctioned was only exceeded by a sum of 302*l.*, which included certain work which (as is usual in such cases) was found necessary as the operation proceeded.

The Author's schemes included the installation of two Shone Hydro-Pneumatic Ejector Stations, one of which is situated near the Great Bridge to raise the sewage from the Medway Wharf sewer to the High Street sewer, and is fitted with one 50-gallon ejector, with a lift of 10 feet, and the other is situated close to Hilden Bridge on the western side of the district; the latter is fitted with two 50-gallon ejectors, and raises the sewage in London Road into the gravitating sewer with a lift of 50 feet.

The chambers are built in High Brooms pressed bricks, lined with white glazed bricks with arched roofs.

The air for working the ejectors is compressed at the sewage works, and is conveyed to the stations by 2½-inch cast iron pipes which are laid throughout their length at an average depth of a little over 3 feet, and were tested in sections before covering in at a pressure of 40 lbs. to the square inch; rising mains consist of 5-inch spigot and socket pipes with caulked lead joints. Since the ejectors were laid down about three years ago they have given great satisfaction. The Wharf Station is 1200 yards and the Hilden Station 2770 yards from the air-compressing works, and the cost of compressing is practically nil, as the compressors are at work whilst other pumping is being done.

The old southern outfall sewer, which consisted of a 27-inch brick barrel, was replaced by a new 21-inch sewer which was laid with Sykes' patent screw-jointed pipes until the wet ground was got through, and thence in ordinary pipes with gasket and cement joints; these pipes have made an excellent job, the greatest care being exercised in laying, more especially as the gradient for a distance of 2378 feet was an exceedingly flat one, namely 1 in 1585. The working of this sewer has been exceedingly satisfactory, as owing to the excellent quality and glazing of the interior of the pipes it has kept perfectly free from deposit. Some of the other sewers it was also necessary to lay at very flat gradients, but the additional care exercised in laying the pipes has been amply repaid by their efficiency. The old 27-inch barrel above referred to is now used as a relief for storm-water overflow with aluminium valves, and discharges into the stream close to the sewage works.

All the manholes throughout are built in High Brooms pressed bricks in cement, with arched roofs and solid iron covers and frames; the inverts are formed of glazed stoneware or cement channel pipes with blue bull-nosed brick benchings. Lampholes are formed with 8-inch Sykes' screw-jointed pipes, with a 6-inch concrete surround and iron covers.

Sewer ventilation was originally obtained by means of surface gratings, but as complaints were continually being made of the smells arising therefrom, they have been abolished and 6-inch iron shafts fixed to convenient adjacent houses have been substituted with good results.

The total length of new soil and surface water sewers laid in the district during the last five years by the Council and the owners of private estates under the Author's supervision amounts to 8½ miles.

Sewage Works.

These works are situated about half a mile east from the centre of the town and to the south of the River Medway.

The original works were constructed when the town was sewered in 1872–5 and comprised a storage tank, boiler and engine house; the original engine is still used to pump sludge to the upper land, but is nearly worn out. In 1891, owing to the increased quantity of sewage and the nuisance arising from flowing the land with crude sewage, additional works were de-

signed and carried out by Messrs. Chatterton and Bazalgette, of London, and comprised a pair of concrete precipitating tanks, each 108 feet long by 14 feet 6 inches wide and averaging 6 feet 6 inches deep, built on rolled iron joists over the old tanks, engine house, press and lime house, with two Crossley's 6 nominal horse-power gas engines, two pairs of Waller's pumps of the bucket and plunger type, two of Goddard, Massey and Warner's filter presses, and an air compressor and lime mixer by the same firm. These tanks were evidently built in the manner described in order to get sufficient head to flow, after precipitation, on to the low-lying part of the farm (about 15 acres) which, needless to say, is least adapted for the purpose, the surface of the ground averaging hardly three feet above the ground water level, and it has been allowed to take nearly the whole of the sewage. The filter presses were used for a very short time only, nor has the Author reverted to their use, as the cost of pressing was considered too great, and the cake could not be disposed of. They were therefore removed about two years ago, with the exception of one of the sludge delivery standards, and the sludge is now blown through a 2-inch galvanised pipe on to the adjoining farm, and run into bays formed of burnt and screened house refuse; the sludge soon dries and can be easily carted away.

Only a small quantity of alumino-ferric is used for precipitating, the cost for this purpose amounting to 12*l.* or 15*l.* per annum; it is placed in baskets in the delivery channels from the pump to the tank, and is dissolved by the sewage as it flows by.

As there were no means of getting the sewage on to the high land, except a small quantity of crude sewage by the original steam pump, the Author was instructed early last year to construct a new set of tanks on the highest point of the farm; these tanks are served from an ejector station with two 150-gallon ejectors placed close to the southern outfall sewer soon after it enters the farm, and take automatically the quantity of sewage they can lift according to the air pressure available. The lift is 70 feet, through 330 yards of 7-inch iron rising main, and requires 27 lbs. of air to work. The tanks, which are built in High Brooms bricks in cement, rendered inside and coped with blue Staffordshire coping, are 130 feet long by 25 feet wide and an average depth of 6 feet, divided into five compartments and arranged to work as one series or in series of

three or two tanks respectively, as required for cleaning. The tank effluent passes from one tank to another and so on, falling from the surface of the end tank into an open channel, and thence to the carriers on the farm; floating arms and disc valves are provided for emptying the tanks and clearing sludge, the latter gravitating to prepared sludge beds.

The cost of the works was as follows:—

	£	s.	d.
Messrs. Punnet and Son, tanks and ejector station	649	10	7
„ Hughes and Lancaster, ejectors, air and rising main	645	15	6
„ Stone and Co., valves, &c.	18	6	10
	£1318	12	11

The Author's estimate was 1325*l.*

The reason why ejectors were put down to raise the sewage to the new high-level tanks instead of high-pressure pumps was because it was thought that when the electricity works are erected the whole of the pumping could be done by compressed air, the compressors being put down at the electricity works, thus utilising the waste steam during the daytime when it will probably not be required for generating purposes, and a portion of the staff at the sewage works could also be dispensed with.

In 1898 an experimental bacteria filter bed was constructed by the Author in conjunction with Dr. Tew, Medical Officer of Health, by utilising a portion of the old storm bed adjoining the tanks, the three walls being raised to the necessary height, and an entirely new wall built on the west side, the finished size of the filter being 45 feet long by an average width of 25 feet, and 4 feet 6 inches in depth. The floor was formed of cement concrete laid to proper levels to an outlet governed by a screw-down valve, and discharging into one of the existing brick effluent carriers.

The floor of the bed has a centre line of 4-inch agricultural pipes, and eighteen rows of 2-inch pipes on either side laid herring-bone fashion. These pipes are packed round with large pieces of coke. The next portion of the filtering medium is 15 inches of 1½-inch coke, then 9 inches of ¾-inch coke, and then about 6 inches of fine coke breeze. There are eight ventilating pipes and the bed is charged from the precipitation tanks with a head of 4 feet 6 inches, the sewage being distributed over the entire surface of the bed by means of iron pipes, which have about 350 perforations.

The sewage is first roughly screened and passes rapidly through one of the precipitating tanks after a very slight admixture of alumino-ferric. The sewage is received on to the bed, allowed to remain for two hours, emptied, and the filter left to aërate for two hours before refilling; thus three charges can be dealt with during the day, and the bed left to aërate during the night, as no sewage pumping whatever is done at the works between 5·30 p.m. and 7 a.m.

The results have been very satisfactory, the effect being a better effluent than what is obtained from the land, and the Author has been instructed to prepare a second bed of rather larger dimensions, and which will probably be completed during the present month; screened railway engine ashes are being used in place of coke breeze, and equal results to the first bed are anticipated, although it is proposed to work them conjointly.

The farm comprises 34 acres, the upper portion being a stiff loam, and the low land alluvium on stiff clay.

The land has been worked under the bailiff's (Mr. Bridges) supervision for some years past, the principal crops being mangold, ryegrass, beans, swedes, cabbages, osiers, in addition to small lots of wheat, celery, tomatoes, parsnips, etc.

The following table shows the expenditure and receipts for the last four years, including rates and taxes, repairs, etc., but not repayments on loan.

	Expenditure.			Receipts.		
	£	s.	d.	£	s.	d.
Year ending March 31, 1897..	457	0	0	453	0	0
" " 1898..	385	0	0	476	0	0
" " 1899..	320	0	0	449	0	6
" " 1900..	371	0	0	468	0	0

Within the last few years the Author has had a large portion of the low land deep-trenched and under-drained, and considerable lengths of brick carriers have been put down.

House Scavenging.

This work is carried out by the Council with their own staff, but up to the present time we have not been able to get round the district oftener than once a fortnight.

The question of putting the work out to contract has been before the Council on several occasions, but as yet nothing definite has been done in that direction.

A destructor scheme has also been prepared by the Author, but it has been decided to leave it alone for the present.

The refuse is now ridged and burnt in the open air; there is no difficulty in keeping the refuse burning all the year round, thus showing that there is a decided calorific value in the refuse, and there is a great demand for clinker in the neighbourhood at 2*s*. 6*d*. a load.

Isolation Hospital.

The infectious diseases hospital was erected in 1881, and occupies an excellent position about a mile south-east of the town. The buildings, which are built in red brick and tiled, comprise: administration block, connected by means of a covered way on either side with two pavilions, each containing male and female wards for three patients each; nurses' rooms, etc.; in the rear are dry heat disinfecting chamber, mortuary, laundry, etc.

In 1895 during the scarlet fever epidemic, the Author received instructions to erect a temporary corrugated iron ward for eight adult patients; the building was erected, furnished and ready for use in four days, including foundations and drainage, at a cost of about 250*l*., and has since been found of great convenience.

The hospital was also in the same year entirely redrained, heated with hot water and supplied by a special main with water from the water company's reservoir.

Although the hospital is described and illustrated in one of the Supplements of the Local Government Board's Reports as a model, this is far from being the opinion of the Medical Officer of Health and the Author, and in all probability a few years' time will see a new hospital for the district.

Fire Brigade.

At present this is a joint brigade for the district and is managed by a committee, the Council paying a yearly sum and certain plant for work required in their district; but negotiations are now taking place, with a view to the brigade being taken over by the Council. The present station is a wretched building behind the old free library, but as those premises will shortly be sold a new fire station will be erected on the Castle property.

Recreation and Pleasure Grounds.

For many years two fields have been rented as playgrounds, one in the centre of the town and known as Botany Field, 5 acres in extent, and the other at the southern end of the town and known as "Bloodshots," 14 acres in extent.

Early in 1897 it became known to the Council that Tonbridge Castle was in the market, and as it had been generally felt for many years by the inhabitants of Tonbridge that this beautiful and historic property should belong to the town, negotiations were opened with the owner, Lady Stafford, and on March 1, 1897, the Council very wisely decided to purchase the Castle and grounds at the price of 9727*l.*, as a permanent memorial of the sixtieth year of Her Majesty's happy reign. The decision of the Council was practically unanimous and was most enthusiastically upheld by the ratepayers at a crowded public meeting held on the 23rd of the same month.

The existing tenancy was terminated last autumn, and early in the present year the Council commenced the use of the buildings as offices, council chamber, etc. Certain repairs have been carried out internally, but as yet nothing has been done to the exterior of the buildings. The north-west portion of the grounds has been set aside for fire brigade station, electric light works, depôt, etc., the necessary buildings for which will be erected in due course, and the remainder of the grounds were on May 23, 1900, publicly dedicated by the Right Hon. Earl of Stanhope, Lord Lieutenant of Kent, as a public park or pleasure grounds.

The grounds thus acquired by the Council comprise about 13½ acres, are charmingly picturesque and of great historic interest. The site of the present castle and mound were used under the Norman kings for a castle of considerable size and importance, but it is evident that a fortress existed here long before the Conquest, and the mound is considered to be of British origin. The history of the place from the eleventh century is fairly reliable and mainly forms the story of the town. The castle was last used for military purposes during the Civil War, was dismantled late in the eighteenth century, and that part of the building now used as offices was erected.

The existing remains of the old castle are full of interest and date back to the thirteenth century. The chief features are

the two semicircular towers forming the gateway, with donjon below, ward rooms on either side and chambers above, which are approached by circular stone staircases; the eastern tower is also connected to the mound or keep by a curtain wall; a considerable length of wall is also visible along the river front. Unfortunately, or it may be fortunately, the Urban Council of Tonbridge is not a wealthy body, so that the work of beautifying the grounds will be a gradual one, but the intention is as far as possible to retain the natural beauty of the place rather than to make it an artificial garden.

Since the Council took possession, however, considerable improvements have been made, namely, the forming and tar paving of a large number of the paths, fencing, etc., and constructing the riverside promenade which replaces a tangled labyrinth of old fruit-trees and bushes.

It is also decided—and the Author is at the present time preparing plans—to construct a new entrance from the north end of the Great Bridge in High Street.

Technical Institute and Free Library.

Tonbridge was one of the first of the smaller towns to take advantage of the Public Libraries Act, which was adopted in 1881, the present inadequate premises being then purchased for the purpose, the upper portion being used as council offices. The lending and reference departments contain about 6000 volumes, and the reading room is well supplied with daily and weekly papers and periodials, both departments being used largely by all classes.

Owing to the rapid growth of the town and the necessity for proper premises in which to carry out technical education, which has been done in hired rooms in various parts of the town, the Council in 1896 decided to build a new free library and technical institute. The Local Government Board's sanction for a loan of 850*l.* for purchasing a site having been obtained, the Council invited competitive designs for the buildings, and in response to the advertisement twenty-eight sets of plans were sent in, and with the assistance of an assessor in the person of Mr. F. W. Hunt, F.R.I.B.A., the first premium was awarded to Mr. J. H. Phillips, M.S.A., of Cardiff, who was duly instructed to carry out the work, and it is now rapidly nearing completion,

the contract being executed by Mr. R. Langridge at the sum of 5650*l.*

An additional sum of 500*l.* was voted for furnishing, etc., which will bring the total cost to a little over 7000*l.*

It occupies a corner site in High Street, and is built of brick with tile roofs. Monks Park and Box Ground Bath stone is used for dressings.

The ground floor is mainly devoted to the Library, with entrance from High Street.

The site being limited in area, the problem was to utilise all available space in order to provide the necessary accommodation, and yet to adequately light the rooms. This has been accomplished.

The left side of entrance is the reference room, 26 feet by 17 feet, and on the opposite side the reading room, 42 feet by 23 feet. Facing the entrance is the lending library occupying an area of 980 square feet together with librarian's room, stores, lavatory and w.c.

The arrangement is such that the librarian has absolute control over reference room, reading room and the entrance. This floor is laid with wood blocks.

The entrance to the technical schools is from the side street and is, therefore, quite distinct from the library. Accommodation is as follows:—

Basement.—Plumbers' shop, 23 feet by 18 feet 6 inches; heating chamber, etc.

Ground Floor.—Joiners' shop, 24 feet by 19 feet.

First Floor.—Lecture hall, 50 feet by 24 feet, capable of being divided into two rooms; chemical laboratory, 31 feet by 18 feet, arranged for about twenty students; two class rooms, 26 feet by 17 feet and 21 feet by 20 feet.

Second Floor.—Art room, 50 feet by 24 feet; modelling room, 31 feet by 18 feet; art master's room and large stores.

Caretaker's quarters comprise living room, parlour, scullery, pantry and two bedrooms.

Two concrete staircases reach these floors for males and females respectively, and cloak rooms and lavatories, etc., are arranged on mezzanine floors over technical entrance.

A secretary's room is conveniently arranged on the ground floor communicating with the technical section and the library.

A small lift is arranged for heating chamber to each floor.

The building is heated by hot-water pipes and radiators, and the ventilation by means of separate air flues connected with tubes in ceiling terminating in a large extractor on ridge.

Windows are arranged to open at bottom and ceiling level, and in addition air inlet panels are provided in the walls at proper heights.

Bye-Laws.

The Council have adopted the Model Bye-Laws with additions and amendments, and have also sanctioned combined drainage if carried out in accordance with the diagram prepared by the Author.

DISCUSSION.

Mr. W. Weaver: I am sure you will join with me in according a hearty vote of thanks to Mr. Bradley for the interesting paper which he has presented to the meeting. There is no reason why Mr. Bradley should apologise in his introductory remarks for the smallness of the town and its work. I think you will agree with me that it is not always the magnitude of the works that impresses the Members of this Association. My own experience is that in visiting small towns we pick up wrinkles from details which, in larger towns, often escape the personal attention of the engineer in charge. In the carrying out of small works the engineer is able to devote his personal attention to the details, but in the carrying out of larger works those details have, in many cases, to be left to assistants, who do not always devote the time and thought to them which would be given by the chief if carrying them out himself. Often the only difference between a small work and a large one is the multiplication or repetition of parts. One or two things struck me as Mr. Bradley was reading his paper. For instance, the question of refuse collecting. I have had a good deal of experience of that; in fact, I have had twenty years' experience of its execution by contract, and twenty years' experience of doing it by direct labour; and, putting it in general terms, the result, to my mind, is, that by self performance the work is a great deal better done, but at a cost greatly in excess of contract execution.

This excess arises from a variety of circumstances which, in the course of a short speech, it is impossible to dilate upon. Then I cannot help thinking that the system followed here of burning refuse in the open air, in a residential district, is likely to provoke complaint. I am sure it would in my district. Of course, if the burning is effected at a considerable distance from the area of collection, the cost of collection is increased by the additional cartage. I should have thought that on the outskirts of the town it would have been possible to have got a pit from which gravel and sand for the roads could have been excavated and then filled up with refuse. There is not the slightest doubt that the erection of destructors in all populous districts must follow as a matter of sanitary protection sooner or later. With respect to Quenast granite, I use 2000 or 3000 tons yearly, to supplement Guernsey granite, but it is not so good as Guernsey. With regard to the castle, there cannot be two opinions about the wisdom of the outlay in acquiring it, and its appearance reminds me very much of Rochester Castle. If as much pleasure is derived from this castle as is given from the one at Rochester, it will prove a very great boon and acquisition to the district. I have very great pleasure in proposing a vote of thanks to Mr. Bradley for the paper he has read to the meeting.

Mr. J. M. Knight: My experience coincides with Mr. Weaver's with regard to the cost of collecting house refuse. There was a time when in my own district it was done for 600*l*. a year, now it costs about 4000*l*. Things have altered so much. The population has increased, and the proportion of valuable and useful refuse has decreased while the quantity has increased. At the present time I am collecting 23,000 loads a year against 13,000 loads a year ten years ago. About 12,000 tons I sift and send to the brickfields. That used to pay very well when the price was 4*s*. 6*d*. per ton, now it is down to 2*s*. per ton. Forty loads a day I burn in cells which I have constructed myself on the principle of Siemens' regenerative furnace. I burn that for 9*d*. per load. The remaining portion I have to take to a place where not we but nature has taken the sand out, on the banks of the Lea. I started burning it in the open air, and so did Mr. Barber of Islington, but we were both stopped, although the nearest house was a quarter of a mile away. I was told that the smell created was intolerable! This is a

pretty town, where Mr. Bradley can devote a good deal of artistic skill to its development, and at the same time retain its original beauty. As to this old castle I do not know that I have seen a prettier place—except Rochester. As to road material, I have found Guernsey granite one-third better than Quenast granite. I have tested it on a road which takes 2000 tons of stone a year, and which I have to make up once a year with Guernsey and once every eight months with Quenast.

Mr. H. Brooke: I should like to ask Mr. Bradley the number of years for which the loan for the High Street improvement was granted by the Local Government Board. When I was surveyor of Richmond, Surrey, the point was raised as to the short period for which a loan for street improvement was granted; twenty-five years was obtained at last, but I consider fifty years in all such cases should be allowed, as it is unfair to the present generation to be saddled with the cost of an improvement which will be beneficial for all time. As regards Penlee stone for macadam, I found it was a first class hard-wearing stone, not so slippery as Guernsey granite. I had no complaints when Penlee stone was well scavenged, and personally prefer it to Quenast stone, but I found, as in all stones of this character, it was essential for it to be kept thoroughly well cleansed, and for the many years I used Penlee Elvan stone I had no complaints such as Mr. Bradley mentions. The cost for making up private roads, which is 23*s.* per foot lineal, seems to me a very heavy figure. At Richmond, where I made up many miles of private streets, and at Hove, Brighton, they rarely came out more than 1*l.* per foot, and I consider in a district like Tonbridge, where the traffic and the whole surroundings will not compare with the places I have named, private streets ought to be able to be made at 1*l.* per foot. In the rural district I represent now, it rarely costs more than 10*s.* per foot. As to scavenging, I have had both systems under my charge. I consider it is best done by our own staff. At Richmond where I had to reorganise the whole of the scavenging, I advocated doing the work by the vestry's staff. I changed from a (so-called) fortnightly collection to a weekly collection under an inspector, when complaints were in a very short period reduced from the number received daily to even a less number in a whole year. I should think in a residential district like this, burning refuse in the open air is a very dangerous experiment. At Richmond they would not even

have a destructor, and, after erecting one, went back to the system of sending it by rail to another district. I should have thought that in this neighbourhood they could have utilised an old disused quarry. By-and-by refuse will not be so valuable for brickmakers and others as at present, for if coal rises to 35*s*. or 40*s*. a ton, the refuse will not contain so many cinders, and therefore will not be so much sought after. The refuse of one of the London vestries, a lot from Rochester, and the whole from Gravesend, is brought to the Strood district, mostly for brickmakers, and, after screening, for farmers. I quite agree with Mr. Weaver's remarks, that in small towns we very often obtain very valuable information, as many more of us represent districts of from 20,000 to 30,000, and even a smaller number of inhabitants, than the very large and populous towns.

Mr. J. Manley: Mr. Bradley says the town is at present lighted with gas, the High Street with incandescent burners and the other streets with ordinary burners. Is there any special reason why incandescent burners have not been put in all over the town; is it because they have not answered? Then Mr. Bradley says the sewage is passed through one of the precipitating tanks after a very slight admixture of alumino-ferric. It struck me as rather surprising that alumino-ferric should be put in to encourage bacterial action. It seems to me like opposing forces being set to work there.

Mr. J. Patten Barber: I quite agree with Mr. Weaver as to no apology having been necessary from Mr. Bradley in inviting the Association to come to a town of the size of Tonbridge. It is quite evident that not only is a great amount of work being done here, but that the work is being well done. It is always an advantage to see work well done, and a town in which the work of the municipal engineer is carried out as at Tonbridge is certainly worth a visit from the Association. After all, it is not the magnitude of the work we want to see but its character. I congratulate the town of Tonbridge upon having such an engineer as Mr. Bradley, who has thrown so much ability, energy and thoroughness into his work here. The improvement in the High Street has been carried out in a liberal spirit and in a thorough way, worthy of the town. When we turn to the figures of the cost, I think even the most economically disposed ratepayers will consider that the work has been wisely carried out in the interests of the town. I quite agree with Mr. Bradley's

remarks as to the relative durability of Penlee and Quenast stone, but he does not state, however, the reason for the slipperiness of the stone in winter; whether it is from the greasy character of the mud on the road or whether it is owing to frost. Personally I should not think there is much to choose between the slipperiness of Penlee and Quenast stone, *quâ* stone. If anything, I should consider that the Penlee would give a little the better foothold of the two. As to the granite slab channelling in the High Street, it makes a good channel, but I find it better to put outside the flat granite kerb a granite set, because the traffic causes the kerb to become rounded and it is then very difficult to hold the macadam, as the edge of the channel becomes worn. The macadam can be better maintained adjoining the granite sett than against the worn and rounded edge of the flat granite channel. I admire the way in which the new streets are made up at Tonbridge. It is somewhat refreshing to find in a country town that the Council will insist upon the streets being made up in a sound manner. One often finds that the influence of the speculative builder is very strong as to the way in which the new streets are made up. In too many places the principle is to make up the new streets very cheaply, leaving a very heavy burden to be borne by the ratepayers when the roads begin to wear away. I am very pleased to see that the Council here are strong enough to insist upon the roads being made up properly and thoroughly, instead of allowing them to be made up as cheaply as possible, with the view of assisting speculators to "develop the town," which would result in the ratepayers eventually having to pay what the owners of property ought to have paid in the first instance. I should like to ask what means Mr. Bradley adopts for flushing the sewers of the town, which I notice are generally laid at very flat gradients. Mr. Knight has referred to the burning of the refuse at Islington. We have a population there of 340,000, and fifteen years ago we used to burn the refuse from that population in the open air, as everybody within a range of a mile or two knew. If the smell of the burning refuse at Mile End was anything worse than that of the Islington scheme, then I am glad I was not surveyor of Mile End. I had to go to this huge mound of slow burning refuse sometimes, but the stench from it was so abominable that I went near no oftener than I could help. However, we had to put out the fire, I am

happy to say. I think the Council will be well advised if they adopt the system of collecting the house refuse by their own staff. It is true it costs more money to do it; but there are certain things in which cost is not the first consideration, especially in matters relating to the health and comfort of the people. It is of the greatest importance that the removal of house refuse should be carried out efficiently, and that can best be done by carrying out the work by men who are directly responsible to the engineer of the Council. When the question comes to be decided, I hope the question of cost will be relegated at least to the second place, and that efficiency will be considered first of all.

Mr. A. M. Fowler: One section of this paper with regard to the sewage works appears to me to be very interesting, but I am sorry to say it has not been so fully discussed as I should have liked to hear. When we talk of burning refuse and setting up these stenches I think my brother surveyors have forgotten for the moment the important point of keeping the dwelling house refuse receptacles free of all garbage and fæcal matter. I notice you have had experience of the bacteria treatment of sewage, and I also notice you have land where you have growing crops. Now, having had experience in municipal engineering in some of the largest towns in England, where I have been engineer in the past, I have always spoken at meetings like this to enforce it upon the younger Members of the Association,—not to endeavour to scavenge at both ends of the sewer! Why should you scavenge at both ends of the sewer when you go to serious expense to do it at the outfall? Why not put all the fæcal matter into that sewer and deal with it at the outfall either by bacteria or intermittent filtration or broad irrigation? Then you have your dry ashes to deal with as you think best. I think one of the speakers said he dealt with the dry refuse to build up street foundations; surely this cannot be the fact. I should like the Author to give us some information of the bacteria treatment of sewage, the character of the sewage, and the quantity of mud, because I notice here it is said that the mud can be easily carted away. When you have large works producing hundreds or thousands of tons of mud it is a very serious question, and if you can show us in this little town how you can get rid of this mud, we shall be very pleased to see how it is done. If you cannot get rid of your mud in a district

like this, surrounded by agriculturists, what are we to do in towns like Stockport, Leeds and other places? It is the most serious problem we have to deal with to-day.

Mr. WEAVER; Before I put the vote of thanks to the meeting, as I think the members of the Tonbridge Council are somewhat concerned about this question of the collection of house refuse, it might afford some little information to them as to the practice of other towns if we were to ascertain in how many it is performed under contract, and in how many by direct labour.

A count was thereupon taken, and it showed that of the towns represented, in twenty-one towns the work was done by their own labour, and in eight towns by contract.

A vote of thanks having been passed for the paper,

Mr. W. L. BRADLEY, in replying, said: With regard to the loan for the High Street improvement, the bulk of the money has been borrowed for fifty years, but in nearly every case we have taken up a small portion of the loan for a short period. That is to say, we buy a property to-day, and in nine or twelve months we sell the surplus land and pay off what we do not require. The bulk of the money has been borrowed for fifty years. With regard to a place of deposit for the refuse, I am sorry to say there is not a place available within decent reach of the town. If there is a gravel pit I should like to be told of it. If we deposited the refuse we should have to go outside the district, and then perhaps get into trouble.

With regard to the incandescent gas lamps in the High Street, I may say the reason we have them there is, that the gas company were good enough to fit them up free of cost, and we have continued them. We provide the mantles and renewals. There is a good deal of vibration from traction engines, and that hastens the end of the mantles.

I am asked as to precipitation at the sewage works in connection with the bacteria filters. We take the sewage which goes into the filter as partially precipitated before it gets there. We take our sewage from the tank. It passes through the tanks rapidly, and we take up the amount we require for the filter beds. The amount of alumino-ferric used is very small indeed.

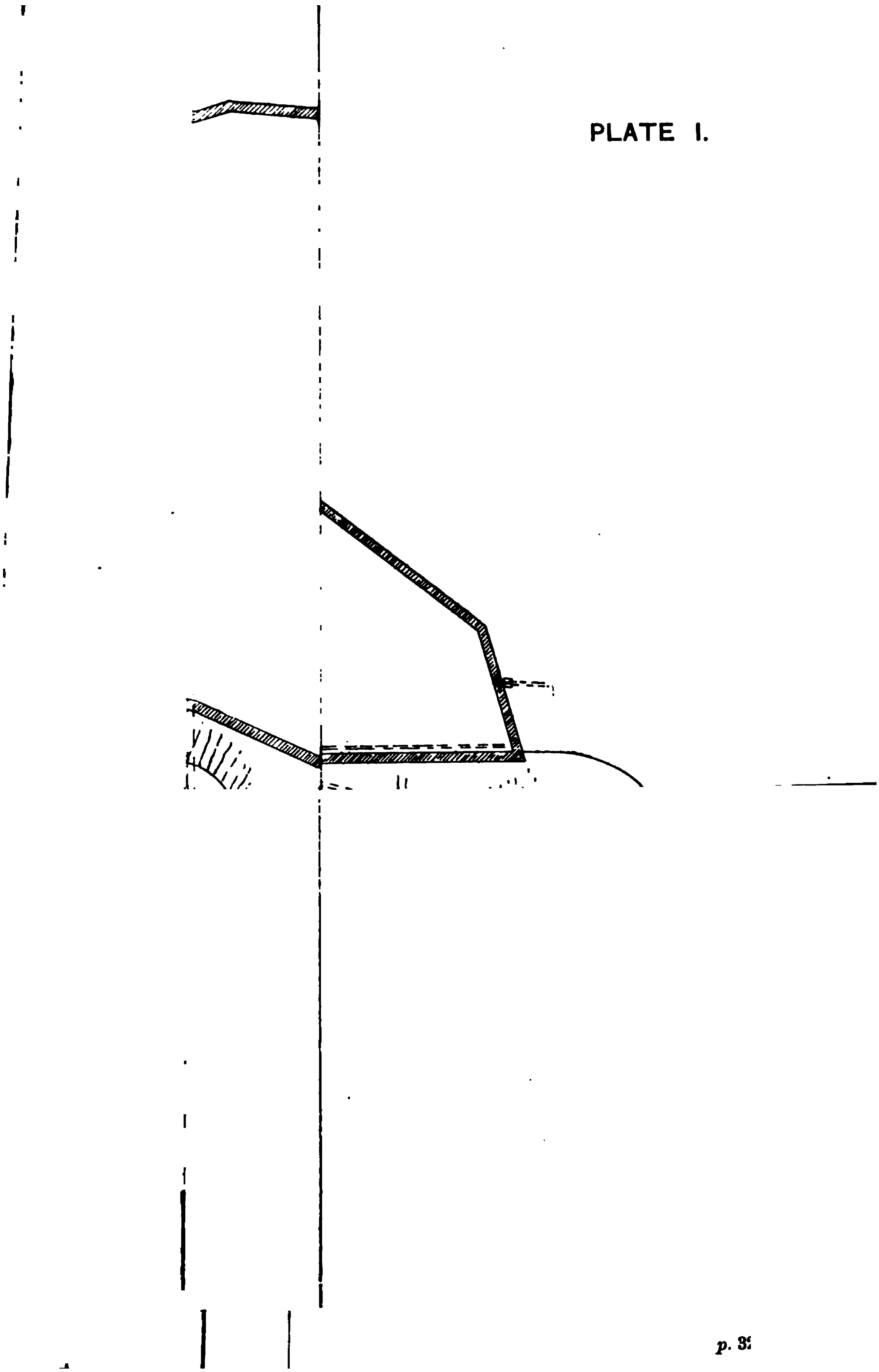
The slipperiness of the Penlee stone is due to greasiness in wet weather, and not to frost. I am glad Mr. Barber referred to the specification for our new streets. We have the same

specification for all new streets. Every person laying out a new street fills up a form, and the specification is appended.

Mr. Weaver: Your price is for the double frontage, and so is not very different from Mr. Brooke's 10s.

Mr. Bradley: With regard to the sewers, we flush by means of vans. In some of the sewers we have valves and penstocks and so on, but the two outfalls always keep themselves clean. I should like the Members to see into one of the manholes. Apart from any theoretical calculations, it is astonishing that there should be such a velocity in so flat a sewer. I attribute it to the way in which the sewers were laid. It is a water-closet town. I do not think we have a privy in the whole district. We screen off the paper, rags, etc., before the sewage enters the receiving tanks at the works, but all the rest goes through the tanks in the ordinary way. The character of the sewage is like what you would expect to find in a residential town. We have a large brewery and a fellmonger's yard. With regard to the sludge, you will have an opportunity of seeing it. The sludge is allowed to dry, and then carted away. There is no trouble at all with it.

PLATE I.



p. 3

ELECTRICITY SUPPLY FOR LIGHTING AND TRAMWAYS, WITH SPECIAL REFERENCE TO SMALL TOWNS.

BY HORACE BOOT, M.I.E.E.,
CONSULTING AND RESIDENT ENGINEER TO THE TUNBRIDGE WELLS CORPORATION.

IN response to your kind invitation to read a paper at the Convention, the Author has much pleasure in submitting a short paper on "Electricity Supply for Lighting, Power and Tramways, with Special Reference to Small Towns," and trusts the few remarks may be of value to your Association. It is surprising within a very few years, the large number of towns that have started municipal electric supply works, for lighting and traction, and there is an excellent list of these towns published in sheet form by the proprietors of the 'Electrical Review,' to which the Author would refer any Member should he desire further information relating to the industry.

A local authority having obtained powers, the following questions immediately crop up :—

1. Selection of site.
2. Choice of system.
3. The question of an expert to advise.
4. The extent of area of supply.
5. The capacity of the generating plant.
6. Should street lighting be undertaken ?
7. The price of supply, and whether a rebate should be given, according to the consumption of electricity.
8. Should free wiring be undertaken ?

The difficulties presented in supplying small towns as compared with large ones are manifold, and it may be taken as a general rule, that it is much easier to supply large towns in a successful manner than small ones. There are at

the present moment, a number of small towns which are hesitating as to whether it would pay them to undertake the work themselves, or allow a company to commence operations, and, as the local conditions in each case must be carefully studied before a reliable and correct decision can be arrived at, it is advisable to call in an expert to draw up a report.

For large towns, it is almost always advisable that the local authority should start their own undertaking, both for lighting and traction purposes.

The vexed question of a combination of power stations—capable of supplying electric energy for tramways, motors, lighting, heating and other industrial purposes, has been discussed very frequently for the past two or three years, and, for those Members who desire to possess a more intimate knowledge the Author would recommend them to read the papers that have been written on the subject by various writers; but there is no doubt whatever that, wherever it is possible, there should be *one* power station to supply the whole area, and the policy of multiplying these power stations is incorrect from an economical as well as a practical point of view. A number of towns have thought it advisable to separate the production of electricity for tramways and lighting into different works, which they will find in the future has been a mistake, and has only been brought about by the fact that in all probability the original site selected for the lighting works was badly chosen and unsuitable for future development for the supply of electric energy on a large scale. Only those who are intimately associated with the industry, can appreciate the difficulties experienced in obtaining a good supply of fuel, and works should never be placed in such a position that fuel can only be obtained by carting. The site should be selected, if possible, where a railway siding can be obtained, or "water-borne" coal can be used.

An important point to bear in mind is also the question of nuisances, as works of any magnitude cannot be run without creating a certain amount of nuisance, such as smoke, vibration, and noise; and the Author ventures to think that if the sites already selected for the supply station were again considered, a large number of them would prove to be unsuitable—hence the necessity for constructing more than one power station. There are, of course, certain conditions which arise in towns,

necessitating the adoption of more than one power house, but the Author is of the opinion that the future will see the development of large power stations supplying large areas, in preference to little stations supplying *local* areas. The advantages of such will be:—Facilities for obtaining fuel; all nuisances localised to one spot; the advantage of water-carriage, with an adequate supply of water for condensing purposes; the small amount of labour required for one works to work successfully, as compared with that for a number of small works; the advisability and advantage gained by having the staff in one place. The only objection that can be raised to it, is the question of fire or total disablement of the works, causing a complete stoppage of the supply. The likelihood of fire should be impossible, if the works are properly designed—as nothing inflammable should be permitted in their construction. The other item to consider is an accident to the boilers, causing a serious explosion. This, again, is not likely to happen where first-class supervision and a good water supply can be obtained; but is more likely to happen where a number of works, without sufficient supervision, are established. In fact, too much consideration cannot be given to the selection of the site, as, to a large extent, the whole question of successful working—both financially and from an engineering point of view—hinges on it. In selecting the site, it is therefore advisable:—

1. To obtain a good water supply to enable condensing operations to be carried out cheaply, and without a great deal of auxiliary machinery.

2. The facilities for obtaining coal at the cheapest possible rate—either sea or rail-borne.

3. The site should be chosen where the works are likely to be the least nuisance to surrounding property.

4. Facilities should be obtained for getting goods of a heavy nature.

5. Provision should be made for future extensions, without having to buy up surrounding property.

6. The nearest point to the centre of the demand, which complies with the above conditions, should be selected, although it is not difficult to transmit electric power to large distances economically.

In the case of large works, it is very convenient to find accommodation in or near the site for the principal workmen

employed; as should anything go wrong with the machinery, necessitating a temporary extinction of the lights, the men can be easily fetched. This especially applies to the mains superintendent, who should always be accessible, and for this purpose it is often found advisable to buy up the surrounding cottage property, or build cottages for the men.

The employment of "experts" to advise is rather a vexed question; but for towns to commence operations without having the advantage of expert advice, is suicidal, as a mistake made in the selection of site will prove fatal to the undertaking; and unless a town can afford to pay an adequate salary to a first-class resident engineer who is competent to advise them, it is advisable for them to obtain a report, and carry out the work under instructions of the practical expert, appointing a resident engineer to act under him; and the Author suggests that a good practical expert, who *is* or *has* been employed in similar practical work, should be called in to advise on the selection of the site, the policy to be adopted, and the system used, afterwards engaging a resident manager to look after the commercial and technical sides of the undertaking, retaining the consulting expert, either by means of a percentage, or paying him an annual retaining fee. This arrangement enables small towns to obtain expert advice at a minimum expense. The advantages of starting works in small towns is greater than that in large, because large towns usually possess sufficient industries to find employment, whereas in a small town, it creates an entirely new industry, gives employment to many men, and improves the town from a sanitary point of view, and where public lighting is undertaken, provides a means of decreasing crime.

Small Works.

It is impossible to find a man willing to accept a small salary and be capable of advising on all the intricate questions met with in the maintenance and construction of an undertaking, which, though it may be small in size, has the same principles involved as that of a large undertaking.

Many towns have started, or are contemplating starting dust-destructor works in combination with electricity works, and there is no doubt that from the figures recently obtained from the various combined works throughout the country, a

considerable saving in fuel is effected by burning refuse; and it has been found that in the latest type of destructors 1 lb. of refuse will evaporate ·79 lb. of water from, and at 212° F. Shoreditch was one of the first works put down, and has been able to produce exceedingly low fuel consumption figures compared with other electricity works. However, a refuse destructor should be designed to fulfil the following conditions:—

1. It must not be a nuisance to the surrounding neighbourhood.

2. There must be very little smoke issuing from the shaft.

3. There must be no dust scattered about, or taken up the chimney shaft.

4. The destruction of the refuse must be complete.

5. It must be capable of raising high pressure steam in sufficient quantity to be able to utilise it for commercial purposes.

It has been found from experience, that the refuse in watering places is worth nearly five tons of Welsh steam coal per 35,000 inhabitants per day.

The Author has been able to make a careful inspection of the working of the Llandudno dust destructor during a short stay in that town, which is built on the "Beaman and Deas" principle, with Babcock and Wilcox boilers. He does not consider that this destructor complies with the conditions necessary, although as an economical steam generator it has proved a very big success, and the figure arrived at in fuel by the Llandudno electricity works, of something under one halfpenny per Board of Trade Unit generated, is much below the average for a similar undertaking. These results are better than were ever anticipated. However, the principal difficulty appears to be that when one is 100 yards away from the works, in the windward direction, a considerable smell exists. Another disadvantage is that during the time the refuse is being destroyed, white or brown smoke issues from the shaft, which smoke is a nuisance to the surrounding property. So far as the other advantages are concerned, this destructor fulfils them absolutely. No doubt there are many Members present who are more competent to speak, and to give us their opinions on the subject than the Author, and it will be interesting to hear their remarks upon the same—as everybody must be agreed that the only way of dealing with refuse in a sanitary manner is to cremate it. A very interesting paper was read before

the Institution of Civil Engineers (in the discussion upon which the Author took part), by Mr. Charles Russell, Electrical Engineer of Shoreditch, in which he deals minutely with the troubles and difficulties, and the value of dust destructor plant. In these proceedings, he gives a curve showing the actual amount of work done by the refuse, and the amount of coal burnt, also a curve showing the available steam pressure. Of course the value of the residue for road making and builder's purposes, is an item which is worthy of consideration, and from Mr. Russell's paper the Author culls the following percentages of which the residue is composed :—

	Per cent.
1. Common clinker	29·0
2. Fine ash	2·7
3. Fine dust	0·5
4. Old tins	0·6
Total	32·8 per cent.

There is a tendency on the part of most destructors to emit from the shaft particles of fine dust. However, several of the contractors have endeavoured to obviate this difficulty by "dust catchers," which can be readily cleaned out. Another use for the residue is the making of artificial paving stones, and the Author believes he is right in saying that Shoreditch uses these stones very largely.

The labour item is a very important one, as at Shoreditch it works out at 2*s.* 6*d.*, at Llandudno 1*s.* 4*d.*, and Hereford 1*s.* 1*d.*

The most satisfactory way of running refuse destructor works in combination with electricity works is to have some of the boilers arranged for hand firing with coal, so that these boilers can act as a reservoir of steam, and assist in steadying the general steam pressure throughout.

The capital outlay for the establishment of electricity works varies to a large extent with the local circumstances, and if a consulting engineer be employed to draw up a scheme, he will no doubt give the capital outlay required to carry out this scheme in the report. However, it must not be forgotten that since the loans to corporations in the provinces are only granted for twenty-five years, every £100, saved in the capital outlay represents £6 less to be charged against the revenue account for interest and redemption fund. There are many methods by which corporations can raise money for this purpose. It is,

however, always necessary to obtain the sanction of the Local Government Board for the requisite loan, after which stock may be issued, or any of the well-known financial arrangements entered into. Precautions should be taken that the corporation does not borrow the capital *before* it can be actively employed, or in other words, produce a return.

A rough idea of the amount of capital required, is given in the following table:—

Number of Lamps in 8 c.p. or their Equivalent.	Approximate Capital Outlay required.
Lamps.	£
2,000	8000
5,000	12,000
10,000	20,000
20,000	35,000
40,000	69,000
100,000	170,000

In selecting a site, consideration must be given to the system by which it is proposed to supply the town, whether high or low pressure. Should it be proposed to generate high-pressure currents at the works, it will not matter if the site be chosen outside the area of supply, but, should the town lend itself to a low-pressure system, then the site must be chosen as near as possible to the centre of the demand, otherwise, useless expenditure will be incurred on heavy copper feeders.

In the early days, there was great diversity of opinion possessed by experts, as to which was the best system to supply, and there is no doubt that what might be the right system for one town, is not necessarily so for another, as both systems have their respective advantages. Large scattered areas can only be supplied by high tension, whereas towns of a compact nature can be more cheaply supplied with low tension. For those Members who are familiar with the technical expression "high" and "low tension," the Author submits the following explanation. Electricity is simply a form of energy existing in nature, which requires special machinery to set it in motion—the same way, as in coal, there is no energy or life, until it is burning. The measurement of electricity is composed of two factors. The product of the factors (when multiplied together) are termed "watts." Either factor may be altered, and yet the amount of energy would remain the same. For instance—one unit of current called the "ampère" multiplied by 100 units of pressure called the "volts" equals the energy which would be 100—or,

it would equal 100 units of current multiplied by 1 unit of pressure. In the former case you might call it high pressure, in the latter you might call it low pressure, except that for the sake of simplicity the Board of Trade have stated that anything over 500 volts must be considered as high pressure. The systems are:—

1. The high-pressure alternating current system.
2. The high-pressure continuous current system.
3. The low-pressure continuous current system.
4. The low-pressure alternating current system.

But the principal ones adopted are:—(1) the high-pressure, and (3) the low-pressure continuous current. In fact all the schemes are based on these.

There are at the present moment no less than 112 electricity works in operation, owned by Local Authorities and 94 companies. There are 81 Local Authorities who have decided to establish electricity works at once, and there are no less than 115 provisional orders granted to Local Authorities, but works not yet finally decided upon. From the financial results of the undertakings, which have been working for more than one year, ample proof can be found that, if well managed, they can be a financial success. It must not be forgotten, however, that many of the undertakings that show deficits are in reality buying their works on what might be termed "the easy payment system," that is to say, in 25 or 42 years as the case may be, the works will become the property of the general ratepayers, having been bought by the consumers, by setting aside so much per annum, before declaring a net profit, keeping the works in thorough repair all the time.

The distribution from the works may be effected by several means, but the latest practice for low tension is to lay three conductors side by side in the same trench of the following types:—

1. Bare conductors carried on insulators in concrete or iron conduits. This system is being superseded now on account of the increase in the pressure of supply to consumers.

2. Three insulated single conductors laid in troughs, and run up solid with some suitable material.

3. Concentric cables, armoured, and laid directly in the ground, with bricks or timber to protect them from picks.

4. Singles cables drawn into stoneware conduits.

5. Three-core armoured cable laid directly in the ground.

For distribution by alternating currents, the system most used is the armoured concentric cable, laid directly in the ground or in troughs, run in some hard compound, in which case it is not necessary for the cable to be armoured. This forms a cheap means of laying cable, besides being very durable.

There are, of course, a number of different means by which the energy can be regulated from sub-stations, but in this paper there is no time to deal with them.

With regard to the overhead system, which is unfavourably entertained by the Board of Trade, the Author believes that in the future we shall see more use made of this, for transmission of high-pressure currents to long distances, for the lighting purposes of country villages, and for farming industrial purposes, as there is no doubt that high-pressure energy can be transmitted perfectly safely, the same as is done in Switzerland and other countries on a large scale.

The water proposed to be used should be carefully analysed before a decision is come to, with respect to its suitability. If possible, it should be obtained simply for the cost of pumping, that is to say, a well should be sunk, and ample supply be obtained at a figure not exceeding 6*d.* per 1000 gallons. There should, of course, be an independent supply from the town mains, in the event of a spring failing in very dry weather. In making arrangments for the water supply, it is important that due regard should be given to the extensions, and the heavy demand that will be required at a future date; it is not enough to arrange for a sufficient amount of water for two years, but the quantity should be at least trebled in making calculations. If the works are situated near a river or canal, care must be taken with the foundations, as any settling will cause serious trouble with hot bearings, leaky joints, etc.

The Tunbridge Wells water for steam raising purposes is extremely troublesome water to deal with: its corrosive properties are very high, and it may be interesting to give you the analysis of the water used.

Well Water.

	Grains per Gallon.
Calcium carbonate	·70
Calcium sulphate	7·43
Sodium chloride	5·61
Oxide of iron	·81
Nitrates and nitrites of lime and magnesia	3·95
Total	18·50

Town Water.

	Grains per Gallon.
Calcium carbonate	1·75
Calcium sulphate	·53
Magnesium sulphate..	·72
Magnesium nitrate	·90
Sodium chloride..	2·64
Total	6·54

Of course, one of the most successful treatments for the purification of water, is that known as the "Arch-Butt Deeley" process, by which the carbonates of lime or calcium carbonate can be got rid of, and the hardness reduced to something under 4 per cent. It will be noticed from the analysis of the waters given above, that the carbonates are low and the sulphate high, and it has been found from experience that calcium sulphite is one of the most objectionable constituents of boiler water, on account of the hard scale it produces. Mr. Arch-Butt read an excellent paper before the Institution of Mechanical Engineers on the subject of 'The Softening of Water,' in which he shows clearly that certain classes of water do not render themselves amenable to treatment, and in most cases the source has to be given up and a fresh one sought after. This water difficulty has affected the costs in Tunbridge Wells considerably, and it is only those who are familiar with steam raising when using good and bad water, who can appreciate what trouble bad water will give.

In Tunbridge Wells, the cables are armoured, concentric, lead-covered, laid direct in the earth with bricks over them, to protect them from mechanical damage. The insulation is paper, and they have now been laid some six years, and have been found to be exceedingly satisfactory. Tunbridge Wells is a very scattered area to deal with, and there are no less than 100 yards of cable laid per consumer. The total length of cables laid in Tunbridge Wells amounts to 41¾ miles. The Author has found it necessary (owing to the damage done to the cable by contractors breaking the surface of the roads for the purpose of water, sewer and other services) to require that contractors before disturbing the surface must give notice of their intention of so doing, in order to enable a representative to be sent to indicate the position of the main, and see that care is taken when crossing or exposing the cable. Since this

system has been in vogue, not one cable has been damaged. All the cables have been laid by the Corporation's own men, under the Author's supervision.

Price.

The question of price charged for electricity must depend upon the cost of production, which cost of production is made up of the capital outlay, the works costs, and other items. In Tunbridge Wells the price charged is based on the maximum demand system. For the first hour's supply, the price is 6*d.* For units consumed over and above this, the price is 3*d.*, from which it will be seen that consumers who burn their supply for one hour per day per annum pay 6*d.* per unit.

Consumers that burn it on an average of two hours per day per annum, pay 4½*d.* per unit; three hours per day per annum, pay 4*d.* per unit.

Method of Charging for Electricity.

Engineers are agreed that there is only one fair and equitable way of charging for electricity, based on the "Maximum Demand System."

The cost of production is made up as follows:—

1. Fuel.
2. Water.
3. Oil waste and petty stores.
4. Salaries and wages.
5. Repairs and maintenance.
6. Rents, rates and taxes.
7. Sinking or redemption fund.
8. Interest on the capital.
9. Depreciation.
10. Contingencies.

Items 1, 2 and 3 increase in proportion to the number of units generated, that is to say, if four times the number of units are turned out, items 1, 2 and 3 will be nearly four times as much. This is not the case with items 4 to 10; it would be possible for us to turn out four or five times as much energy without increasing these items at all, provided the maximum demand was not greater.

The financial value of the above may be taken as follows:—

	Per Unit.
	d.
Coal, oil, water and waste cost	1·03
Salaries, repairs, sinking fund, interest and depreciation cost..	6·00
Total cost of production for first hour, per unit sold	7·03d.

Now it is clear from the above, that if a consumer burns his lamps for more than one hour per day, the extra additional cost to us will only be 1·03*d.* per unit; and again, the same applies if he goes on burning it for a large number of hours. Take for instance an hotel consuming, on an average, its maximum demand for five hours a day; the total cost of supplying energy to this hotel per unit would be one hour 7·03*d.*, plus four times the cost of oil, coal, water and waste, divided by 5, which equals 2·23*d.*, arrived at as follows:—

	d.
Cost of supply, first hour	7·03
" " second hour	1·03
" " third hour	1·03
" " fourth hour	1·03
" " fifth hour..	1·03
	11·15d.

Average cost per hour $\frac{11 \cdot 15}{5} = 2 \cdot 23d.$ per unit.

It is for this reason that it has become almost a universal practice to charge on the Maximum Demand System, because it is a system which endeavours to obtain an equal rate of profit from all consumers, and does not place the best consumers, i.e. hotels, public-houses and clubs, at an unfair advantage to the consumer who burns his lights for only a short period. It will be seen that we are actually losing money on the consumer who only burns his lights for 365 hours per annum, and that loss has to be made up out of the profits obtained from the paying consumer. In order to establish a successful electricity undertaking, every encouragement should be given to those consumers who burn their lights a *large* number of hours, even if it means the discouragement of the consumer who would be a *loss* to the works. A uniform charge can never be so low as the average price charged on this system,

because a uniform price encourages people to burn their lamps only for a *short* time, and that uniform price would be too expensive for the best consumers, such as hotels, public houses, clubs, etc., to adopt electricity as an illuminant. Short hour consumers do not care for this method of charging, and *they* would prefer a uniform price, where the loss caused to the works by having them on the mains would be paid out of the profits that would be obtained from the profitable class of consumer; unfortunately, however, experience proves that this good class of consumer finds a uniform price too expensive, and eventually gives up the illuminant, not caring to pay for the losses caused by other consumers.

A great point in favour of this system is, that the rate of profit is uniform for all classes.

The instrument used for ascertaining the maximum of each consumer, consists of an hermetically sealed tube, containing air and a liquid, a conductor of short length and a slightly higher resistance than copper. Current passing through the conductor causes a slight generation of heat, which expands the air inside the tube, and forces a portion of the liquid up to the tube adjoining, where it remains permanently, until it is re-set by the meter inspector. The amount of liquid forced up the tube is proportionate to the consumer's maximum demand, or in other words, "the capital outlay that consumer has put the electricity undertaking to, to supply him." There is no mechanism to get out of order, nor can the accuracy of the instrument be doubted.

There are certain laws which govern the principle of trading successfully:—

1. All consumers should be a source of profit.

2. The tariff should provide an equal rate of profit from all consumers.

3. It is sound commercial practice to encourage the profitable, even at the risk of losing the unprofitable.

4. The cost of supplying electricity depends upon the length of time the necessary plant and mains to supply the maximum demand are used.

5. It is only by adopting a correct sliding scale, in direct proportion to the costs, that it is possible to make the tariff sufficiently low to reach the many.

6. The uniform price usually means that a consumer pays two

lighting bills. He installs electricity in his shop windows, and in the places where the light is only burnt for a short time per day, and refuses to put it in such places as cellars, basements, etc., where it is burnt for many hours, because he looks upon it as a luxury. It is this habit which the sliding scale system corrects, because electricity is only installed in corridors, kitchens, bedrooms, workrooms, etc., if it is cheaper than gas, and competition must simply be based upon the cost.

7. The conditions of gas and electricity production are essentially different. In the case of gas, its cost per 1000 cubic feet delivered does not bear any relationship to the maximum, or the number of hours, because gas is never delivered direct, but stored in gasometers.

There is perhaps no business in which capital is employed for so small a number of hours as that of electricity supply, and we ought to do everything within our power to stimulate the large number of hours of demand. In our own undertaking we have expended the sum of 40,000*l.*, approximately, which sum has to earn sufficient revenue to pay all the expenses in 1460 hours per annum, whereas, had the consumers been burning the light evenly all through, we could have employed it profitably for 8760 hours.

4 hours per day, per annum, price	3¾*d.* per unit.
5 " " "	3½*d.* "

It is interesting to note the relative prices obtained from various classes of consumers in Tunbridge Wells :—

	d.
Public houses and hotels, average price paid for electricity ..	3·9
Shops	4·8
Private houses	4·89
Offices (early closing)	6·00
Churches	6·00

From which it will be seen that the public houses and hotels obtain their supply at an exceedingly low rate, and far cheaper than they could ever hope to generate it themselves.

There are many ways of charging for electricity :—

1. Sliding scale, giving long-hour consumers the lowest rate.

2. Uniform price.

3. Percentage rebate on the amount consumed.

4. Percentage rebate on the number of units consumed per lamp.

There are, however, only two of these systems worthy of consideration, viz. the uniform price, and the long-hour consumer rate.

The works should be organised into various departments:—

1. The meter department.
2. The distribution department.
3. Works department.
4. Public lighting department.
5. The clerical department.

Each department should have a responsible official, who again should be responsible to the chief engineer. Of course this is not easy to arrange in small towns of less than 30,000 inhabitants, but where it can be done, greater efficiency and satisfaction are given.

POWER.

In manufacturing towns it pays to develop a motor load, that is to say, that electricity forms one of the best and cheapest methods by which power supply can be given at a reasonable rate; and in Bradford, this question of power supply has been largely developed, there being no less than 411 motors on the Corporation mains, and the units sold to these motors are 463,630 per annum. They are used for every industrial purpose, and a very interesting description of the motors in use is given in Mr. Gibbing's book, section 4, 'Electric Motive Power.' It is of course equally important that the power supply should be developed in small towns as well as large, although in residential and pleasure-seeking towns there cannot be much demand. The price charged for the motor supply should be low, as the energy is used during the day-time, when it is not required for lighting purposes, and otherwise the plant at the works would be standing idle, so that it pays to supply the energy at a rate lower than that charged for lighting, especially as the motor load is a long-hour one.

There are few towns of over 30,000 inhabitants that are not considering the question of establishing tramways, and, especially in residential towns, considerable opposition is experienced; but it must not be forgotten, the advantages of tramways are very great.

1. Tramways conduce to rapid transit from place to place, thus improving the prosperity of the town.

2. Tramways are found by experience to increase trade along the line of route.

3. Tramways form the solution to the "Housing of the Masses."

4. A tramway may be called the "People's Carriage."

5. In the near future, tramways will play an important part in the conveyance of merchandise, and will become severe competitors with the railway companies.

6. Tramways are the only means by which cheap fares and rapid transit can be provided.

7. Tramways mean starting another industry in the town that benefits the community in general.

There are, however, objections which may be summed up as follows:—

1. Tramways convert residential districts into business ones.

2. The unsightly overhead trolley system must be weighed against the advantages gained.

3. The noise along the route.

4. Tramways tend to drive carriage people away.

It is, of course, a well-accepted fact, that the only means to propel tramways is by electric energy.

1. On account of the working expenses, i.e. the low cost per car mile.

2. The ease, comfort and speed in travelling.

3. On account of the easy surmounting of heavy gradients.

4. On account of the freedom from wear and tear on the roads:

(*a*) Fouling the streets.

(*b*) Absence of noise.

(*c*) The freedom from accidents.

It will be seen from the opinion expressed above, that where possible, the lighting and tramway works for the generation of electricity should be under one roof and one management, as only by that means can the full benefits of the combination be obtained.

The plant which is available at night-time for supplying energy for lighting purposes, in the day-time will be available for running the cars, and during the hours of lapping load it might be advisable in the case of small towns to "horse" the

tramways, or have sufficient storage capacity to cope with the demand. There is no doubt that works can be put down at a much cheaper rate per kilowatt than they would be if the works were separated, as the machinery in the case of the lighting works would only be used a very few hours per day, whereas if it were used for both purposes it would be almost in continual use, and the load factor would be improved.

Most of the Members, no doubt, have studied the question of tramways for their own respective towns, and the Author need only refer them to the very successful system in operation at Dover, to show what can be done on a small scale. Space or time does not permit going into details of construction for tramways in this paper, but an account of same can be obtained in the Author's fourth year's report, which contains in the Appendix a copy of the tramway report presented to the Committee, in which are given details, such as the weight of rails, the relative merits of the different systems, the construction of the permanent way, the overhead gear, feeders, gradients, working expenses, etc.

Public Lighting.

It is important for towns undertaking electricity supply, to commence with a thorough system of public lighting, and to light the whole of the district either by arc or incandescent electric lamps along the line of route in which the cables are laid, and the Author advocates the policy of laying the mains well in advance of the demand; this especially applies to small towns, where it has been found that consumers will not come on until they see the actual cable laid, and the policy of extensions may be considered the only speculative part of the business, as it is useless having the works too large with a great deal of idle plant, and the mains only laid in a few streets.

The Author has introduced a system of reflectors, by which he obtains far greater efficiency out of an ordinary lamp for street lighting purposes, and commends it to the notice of the Members of this Association. It can be seen in operation, lighting many of the streets of Tunbridge Wells. The Council have decided to erect 262 additional ones.

In this paper the Author has purposely refrained from giving a detailed description of the Tunbridge Wells Electricity Works, as he hopes to have the honour of showing the Members of this Association round, when they will see for themselves what has been done.

DISCUSSION.

Mr. W. Weaver: This is a very interesting paper, and I am sure that a great number of the matters touched upon in it will be found useful to Members of the Association in the future. Personally, Mr. Boot, I have to thank you on behalf of the President and the Members of the Association for the excellent paper you have taken the trouble to prepare and place before us, and I invite the Members present to join with me in a vote of thanks to you.

Mr. A. D. Greatorex: I have very great pleasure in seconding the vote of thanks to Mr. Boot for his very able and interesting paper. I am sure it is of interest to municipal engineers to have a question so thoroughly gone into as it is in this paper. Of course we are none of us electrical engineers, although some of us occasionally have to do with electrical work. I think this paper is one which should be widely circulated among Corporations and District Councils throughout the country, for it would certainly be an advantage to Members of such Councils who are considering the question of putting down an electrical installation to read it before carrying out such a scheme. I have myself carefully read the paper, and I am very pleased to second the vote of thanks to Mr. Boot.

The vote of thanks having been passed,

Mr. Horace Boot, in acknowledgment, said: I am sure I am very much obliged for the vote of thanks you have passed for the paper. I regret somewhat that I had no more time to prepare it, but owing to the enormous extensions we are now carrying out at Tunbridge Wells works, which will more than double their capacity, I was unable to give the time to the preparation of the paper I should have liked to have given.

THE MAIN ROADS OF KENT, THEIR MAINTENANCE AND REPAIR.

By F. W. BUCK, County Surveyor of Kent.

Having been asked by our local secretary to read a paper at this District Meeting of the Association, the Author hopes that the above subject may prove of interest to the Members, the maintenance of highways being one in which all surveyors are more or less interested. The efficient upkeep of the highways and particularly the main roads of a county is of the greatest importance to the whole community, providing as they do a cheap and ready means of intercommunication. This is proved by the greater amount of traffic thrown upon the roads than formerly, which, before they were properly maintained, was carried by the various railway systems.

At the passing of the Local Government Act, 1888, there were in the county 664½ miles of main roads subdivided as under, and costing the sums stated :—

	Miles.	Cost. £	Per mile. £
In 17 Boroughs	43	7,050	164
„ 18 Local Board Districts	70	15,500	221·5
„ Highway Board Districts.. ..	551½	53,300	96·66

To deal with the rural roads, arrangements were at once made with the various authorities to maintain the roads within their several areas for the first year at a fixed sum, based principally upon an average of the past three years' expenditure. By so doing the county authority gave itself time to carefully consider what system it would adopt in the future. The Author was instructed to visit the counties of Gloucester, Monmouth and Glamorgan, and report upon the systems there in vogue, which he did, and subsequently, in November 1889, submitted a further report upon the three systems open for adoption, namely (1) direct control; (2) annual contracts with highway authorities for a sum mutually to be agreed upon; and (3) open contracts with private firms and highway authorities. This report was circulated and fully discussed, with the result

that the last-mentioned system was decided upon. One fact which probably somewhat impressed the Committee in its decision, was that a similar system was in operation in one of the important highway areas of the county, and had worked with marked success, the cost of the roads having been reduced and their condition much improved. It would also enable the highway authorities to compete within their own districts should they desire to do so.

No alteration of system was made until 1893, when several Members of the Council expressed a strong feeling that a portion if not the whole of the main roads within the county should be maintained under the direct control system. After due consideration by the Bridges and Roads Committee, it was decided in that year to adopt it in Division 5, or the eastern portion of the county lying beyond Canterbury, and comprising 136 miles of main road where the rural authorities had not submitted tenders to the extent that it was hoped they would do, and the competition generally had not been so good as could have been desired.

This system was continued until the close of the year 1898–9, during which period it worked well, but did not show any marked advantage as compared with that of open contracts, which was then reverted to. Before a decision was come to the whole question was most carefully gone into upon data supplied by the Author.

There was in 1898 an endeavour upon the part of a section of the Council to place the maintenance and repair of the roads in the hands of the various District Councils, but under the Author's supervision, when a Sub-Committee of the Council was appointed to take what action and obtain what information it thought necessary or desirable to enable it to report. Upon the report (which was not supported by the Bridges and Roads Committee) being presented it was resolved to continue the contract system, which had in the past worked well. The Author is in favour of triennial contracts, which he has no doubt will be adopted shortly.

From the above statement it will be gathered that various opinions have from time to time been expressed on the question of the best system to be adopted in the county, and the systems have been thoroughly discussed, with the result that the system now obtaining has stood the test of the last ten years.

A few details giving an outline of the system may be of interest. Specimens of the several forms are laid upon the table for inspection, and should any Members desire to have copies, the Author will be pleased to supply them.

The county was originally divided into five divisions with an assistant surveyor appointed to each, but these have now been reduced to four, with an average of about 150 miles in each, which are subdivided into fourteen sections.

These sections have a varying mileage, and are again subdivided into four or five sub-sections, the roads of each being carefully described. The lengths within the sections are made co-terminous with the highway areas.

One of the principal features of this system is that of tendering for specified quantities of material, which are clearly stated upon schedules, giving the sub-sections upon which they will be required, and the method of delivery.

The form of tender for each section is practically a schedule of prices giving the number of yards of each description of material to be delivered into depôt on each sub-section, the material for footpaths, the carting from depôt on to the road, and the rolling-in per cube yard, including watering and the supply of water. The whole of the manual labour, including the spreading of the material, is stated at a fixed sum for each sub-section.

Manual Labour.

The specification, which is very comprehensive, requires, in addition to the ordinary work of maintenance, that all the roads and footpaths through hamlets, villages and towns shall be swept every Saturday or at least once a week, thus securing a tidy appearance in populous districts. When any material is left in depôt, the value of the labour in connection with it that has been saved, is deducted from the contract amount, and the contractor for the following year's contract is paid the usual rates for carting out and rolling, including 3*d.* per yard for spreading. The contractor has to provide, but not to horse, a water-cart for watering when and where required for consolidating the road surface in dry weather.

The road ditches are cleaned out annually, the roads sided in the autumn and spring, and the weeds, long grass, etc., brushed

from the sides of the margins and wastes, but not from under the hedges, before seeding. Any labour needed in excess of the permanent men to remove accumulations of snow is paid for as an extra.

MATERIALS.

The materials used are Kentish rag, a limestone, surface and pit flints, Sevenoaks (chert) stone, gravel (a small quantity only), and Cherbourg quartzite.

Kent being noted for its Kentish rag, it might naturally be supposed that it is a county in which at any rate local materials can be procured without difficulty; but this is not the case, as the quarries are limited to more or less small areas, and the stone is of varying quality, that procured in or near the county town being the best. The surface flints are found in the upper portion of the county, and are at times difficult to procure in sufficient quantities. The chert, which is extracted from a somewhat limited area and at some distance from the railway systems, cannot, therefore be distributed at a reasonable rate. Gravel, a small quantity only of which is used, is dug in the eastern division, and cannot be considered satisfactory, being as a rule too small for road purposes, although the sand and all stones of less than 1½ inches diameter are screened from it.

Cherbourg quartzite is more largely used than any other material, particularly where the traffic is heavy or where there is an absence of local material, it being more economical to use the more durable material and thus save haulage as far as possible. In 1890 Guernsey granite was practically the only "hard" material used, 11,000 yards being rolled in, and in the same year 1000 yards of quartzite were secured for the purpose of testing its quality In 1894 the writer was instructed to visit the quarries and make a special report upon quartzite as a road material, as the first consignment was not of the best quality, and machine-broken, sufficient care not being taken to obtain the supply from the grey or hardest beds. As the result of this report it was decided to use quartzite instead of Guernsey granite, experience having demonstrated that it produces a cleaner road, the surface drying more quickly, and the mud resulting from its wear in wet weather being a clean coarse grit instead of a sticky and greasy substance that is useless for slurrying purposes. It is not liable to be "lifted" by the

traffic immediately after being rolled or after slight frosts, as is the case with granite. Two important advantages that it possesses are that it wears with a smooth surface and is consequently less noisy, and the surface after being worn is free from short squats and isolated pieces of projecting material so noticeable in a Guernsey granite road; also that it can be used upon any hill, it being non-slippery. The whole is broken by hand and thoroughly screened to extract all dust and stone of less than an inch or more than two inches diameter. Quartzite "ballast," which is the stone that passes over the 2-inch screen, and is very uniform in size and about 2½-inch gauge, is used for lining those roads that have been previously coated with only local material.

Rolling and Scarifying.

The Council has very wisely, from the first, rolled the whole of the material spread upon the roads. As the heavy repairs are completed during the five winter months, it necessitates the employment of between thirty and forty rollers at the same time.

The advent of the road scarifier at a very opportune period, and its gradual improvement and subsequent adaptation, whereby it can be attached to the steam roller, has already proved a great boon to the road-maker. The independent machine was first used on the Kent main roads in 1894; since then it has annually been more generally employed, and at present all quartzite surfaces upon which new material is to be spread are previously thoroughly scarified and regulated. In the writer's opinion the simplest and most handy form of scarifier is that attached to the steam roller. The proper use of the scarifier renders it possible to economise the material, a much smaller quantity being required to reline the surface than under the old system. This work has hitherto been paid for by the yard superficial, which has cost about 1*d.*

Additional Works.

All additional works, such as improvements to footpaths and roads, construction of new or repairing of existing depôts, repairs to fences, drains, culverts, mile-marks and direction

posts, and the removal of snow are excluded from the contract, and either tendered for separately or carried out by the road contractor at net cost and 10 per cent. allowed for profit. The following sums have been expended under the various heads, during the last six years:—Footpaths, 11,639*l.*; Improvements, 4795*l.*; Depôts, 726*l.*; Drains, 4937*l.*; Fences, etc., 1071*l.*; Mile-marks, etc., 384*l.*; giving an average annual expenditure of 3923*l.* per mile.

The Cost of the Roads.

It is generally known that the Kent roads cost considerably more than those in other counties, which is not surprising when all the facts are taken into consideration. In this county there is an immense traction-engine traffic, there being no less than 122 licensed engines and 314 registered agricultural engines, all of the former being constantly upon the roads, the majority hauling heavy weights, and some are employed in conveying road material into the adjoining counties. The great cost of the stone, nearly half the total quantity being procured from France, and the high rate of wages ruling throughout the county and particularly near the Metropolitan area, are also facts which should be borne in mind when considering the matter.

A few figures showing the subdivision of the expenditure, etc., may be of interest.

The county is 975,820 acres in extent, the population 808,736, and the rateable value in the rural districts 2,418,123*l.*, and in urban 2,921,755*l.*, making a total of 5,339,878*l.*

The mileage of main roads and expenditure upon them in 1899–1900 were as under:—

Rural, 596 miles costing 74,233*l.* = 124·75*l.* per mile, or 7·36*d.* in the pound on the rateable value.

Urban, 149 miles, estimated cost 58,200*l.* = 390·60*l.* per mile, or 4·78*d.* in the pound on the rateable value.

The subdivision of the rural expenditure is as follows:— Quartzite 37,859 yards, costing 31,840*l.*; Local material 58,094 yards, costing 18,309*l.* = total 95,953 yards, costing 50,149*l.* = 161 yards at 84*l.* per mile, or 10·5*s.* per yard cube.

Manual labour and scarifying:—Total expenditure 12,873*l.* = 21*l.* 11*s.* 10*d.* per mile; Team labour 3821*l.* = 6*l.* 8*s.* 2*d.*

per mile; Rolling 4085*l.* = 6*l.* 17*s.* per mile or 10·21*d.* per yard cube.

From the necessarily heavy outlay upon material it will at once be seen that it is impossible to maintain the roads at anything like the sum expended in many other counties. The material is economically employed, and the writer trusts that those attending the meeting may have an opportunity of judging for themselves before they leave the county, whether the system has given good results.

DISCUSSION.

Mr. W. Weaver: I take it that the chief value of this paper attaches to the fact, that it will be recorded in the minutes of the Association, and serve as a reference for Members for the purpose of comparing the work in different counties as to its cost and method of execution. There are several points, which are of interest, perhaps more especially to county surveyors, and I have very much pleasure in moving a vote of thanks to Mr. Ruck for the trouble he has taken in preparing the paper.

Mr. Knight: I would say how very much obliged I am to Mr. Ruck for the information he has given in this paper. The cost of maintaining roads in rural districts is what I have been awaiting for years. All my experience is in London, and I must admit these figures are altogether different from my ideas of the cost.

Mr. Brooke: I have very much pleasure in supporting the vote of thanks to Mr. Ruck. Some of the items given in the paper caused me some surprise. There has been a good deal of controversy in the county over the matter of the contract system of maintenance of main roads as carried out in Kent. In the Strood district we carry out both systems, one part contract system and in another portion the roads are maintained by our own staff, so I ought to be able to judge a little on each system. I find, from a return I have made of the relative costs of maintenance of the different systems for the past eight years, that while the contract system is cheaper so far as labour is concerned, and there is not the personal interference with such work by District Councillors as in the case of the work being

done direct by the Council, yet I find the rolling stands better when carried out without contractors; but I cannot get my rolling done at the price quoted by Mr. Ruck. At present the contractors are charging 1*s.* per yard cube for rolling, whereas my own staff's work cost me 13½*d.* per yard cube. Another point in favour of contract system is the extra supervision. I find all contractors believe in and keep a sufficient number of foremen, and their labourers are better paid than my men. Then there is more supervision, and more work is obtained thereby; but the Council think a surveyor can do all the supervising necessary, and object to having the necessary number of foremen and gangers I consider necessary in a large district, while for a few shillings a week in extra supervision many pounds would be saved. I have proved it now for the past twenty-five years, and yet I find many councils are still of opinion that foremen are unnecessary, and if engaged, should only be a working one. Therefore in carrying out the contract system in Kent, Mr. Ruck, in my opinion, obtains a better and more efficient supervision of the work than those of us who have only an inferior road foreman to carry out our instructions. As Mr. Ruck's figures are exclusively for main roads, he will no doubt consider mine secondary ones. Yet perhaps many of my roads have far more heavy traffic than many of the main county roads. So, whilst I cannot go into the main road figures, I think a few items will be of interest to many Members of the Association. Most of my granite roads, adjoining and adjacent to Rochester and Gravesend, cost on an average from 73*l.* to 83*l.* per mile; manual labour, from 8*l.* 15*s.* 6*d.* to 10*l.* 10*s.* per mile; materials, from 53*l.* to 60*l.* per mile; team labour, 3*l.* to 4*l.* per mile. Rag and flint roads cost from 40*l.* to 52*l.* per mile; manual labour, 8*l.* to 13*l.* per mile; materials, 18*l.* to 30*l.* per mile; team labour, 3*l.* to 3*l.* 10*s.* 6*d.* per mile. These I have taken from an average of over 100 miles of highways, and all within 30 miles of the centre of London. I think the Cherbourg stone used by Mr. Ruck a great improvement on Guernsey granite; it is, as he states, clean, wears smooth and even, and is very pleasant to cycle over, which cannot be said of Guernsey granite. I use very little Cherbourg stone as my Council are very conservative, and, being in the hilly district where I can obtain good surface picked flints delivered from 4*s.* 10*d.* to 6*s.* 6*d.* per yard, two-thirds of my roads are flint and Kentish rag stone.

I consider Mr. Ruck's figures very valuable, especially to Members representing rural districts, whose chief duties are road maintenance and management, and I have great pleasure in supporting the resolution of thanks.

Mr. W. N. Blair: I wish to ask a question with regard to scarifiers, about which Mr. Ruck may be able to give us some information. Mr. Ruck says that in his opinion the simplest and most handy form of scarifier is that attached to the steam roller. Has that any serious effect on the life of the steam roller, due to cross strain in the frame and vibration transmitted from the scarifier?

Mr. R. J. Thomas: I should be glad if Mr. Ruck could give us the cost per mile of the roads under this system from the inauguration of the County Council. In Kent they have a unique system of advertising and letting the work by public contract. There is no other county that has this system, consequently it would be very interesting to have the cost per mile if it could be added to the paper. I heartily support the vote of thanks.

Mr. Knight: I have had one of these scarifiers at work for twelve months attached to a 10-ton roller, and the strain of the scarifier is communicated to the whole of the roller and not upon one part only. My scarifier has been at work for twelve months and I have not found any injurious effect upon the engine.

Mr. W. H. Leete: My experience of a scarifier attached to a 10-ton roller is that it does very materially shake the engine, loosen the bolts, and upset the bearings. The great objection to a 15-ton roller is of course the liability of damage to gas or water-service pipes, so, taking all contingencies into account, the strain upon the 10-ton roller is perhaps the lesser of the evils to be guarded against.

So far as I have seen other makes, I consider the "Morrison" the most effective and thorough in its work; I have not seen work done so thoroughly as by that machine.

Mr. Card: I was the first to use quartzite in Sussex, on the road between Hove and Aldrington, and I must admit it far exceeded my expectations. As an all-round metal I consider it the best we can get in Sussex. On our hills, where the granite is slippery, I have had to take the granite off the roads again, but where I have used quartzite I have never had to do that.

A vote of thanks having been passed to Mr. Ruck for his paper,

Mr. F. W. Ruck, in replying, said: I am very much obliged to you for the vote of thanks. When I was invited by the Secretary to contribute a paper it was a little difficult for me to decide what to write upon. I quite felt when I prepared the paper that it was a subject which interested rural authorities more than urban authorities; but to go into the whole question of main road maintenance within the latter areas was to raise many knotty points and matters of controversy which made it a topic better left alone. It is known that our roads cost us a large sum, but it must be borne in mind that we have a very heavy traffic on nearly all the main roads throughout the county. I do not think there is any county where the traffic is so heavy throughout. The number of traction engines using the roads is three times greater than on the roads of any adjacent county. If the tank of a steam-roller is properly constructed and braced for receiving the scarifier, it should sustain no damage whatever. I put the question very straight to Messrs. Aveling and Porter, and they said there was little chance of damage resulting to the roller. The advantage of having the scarifier in this form is that you can use it occasionally when required and do small areas of road at a time. You can scarify sufficient with one scarifier to keep three rollers working at a time. The cost of the roads per mile for the whole county has averaged 111*l*. We hope that we shall not exceed our past expenditure on the roads, though our traffic is increasing year by year and the general public require good roads. I do not think, however, that we can do much to reduce our expenditure. We have heard a good deal about Penlee and Quenast, but I have another road material, namely quartzite, which I consider superior to either of them. It is not so slippery as the other hard materials in use, as you can line any hill with it up which a traction engine can pass, and it will give better results and not be slippery at all. Where you have quartzite and Guernsey granite on the same road, it will be noticed that the former will give a drier surface and last as long as Guernsey. In the Crays district, where there is considerable traffic, the two materials were used side by side, and you could easily see where the quartzite commenced and the granite ended; the quartzite lasted quite as long and gave a smoother and drier surface. We have ceased to provide any granite and are now using quartzite exclusively.

Mr. W. Weaver: I have pleasure in moving a vote of

thanks to the Members of the Council for so kindly placing these rooms at our disposal for the purpose of holding our meeting.

The vote of thanks was accorded by acclamation.

At the conclusion of the business proceedings the Members were entertained to luncheon at the Central Hall at the invitation of the Members and Officers of the Urban District Council. The afternoon was devoted to visits of inspection of the Shone Ejector Station, the Sewage Works, Southborough Isolation Hospital and Capel Isolation Hospital, passing through some hop-gardens on the way to the latter institution. In the evening the Members dined together at the Rose and Crown Hotel, under the presidency of Mr. W. Weaver.

DISTRICT MEETING AT DEAL.

September 15, 1900.

Held in the Town Hall, Deal.

W. Weaver, M. Inst. C.E., Vice-President, *in the Chair*.

The Mayor (Alderman Charles W. Thompson) received and heartily welcomed the Members to the town.

Mr. Weaver thanked the Mayor for the warm welcome he had offered the Members.

The following paper was read and discussed:—

SOME MUNICIPAL WORKS IN DEAL.

By T. C. GOLDER,
Borough Surveyor, Deal.

At the request of your local secretary, the Author has arranged for a portion of the two days' meeting in this district to take place in Deal, and in presenting to the Association this paper, which embraces some designs and works of other engineers, he asks for the indulgence of its Members, as he may be somewhat unversed in the ways of the Association.

The subjects which it is intended to bring before the Members are:—

The Sewerage of Deal.
The "Case Groynes" at the north end of Deal.
Underground Conveniences.
Proposed Fever Hospital.
Proposed New Depôt Buildings.
Deal and Walmer Waterworks.

The Sewerage of Deal.

The old sewerage of Deal is entirely by gravitation on the combined system, and there are two outfalls; one being at the south end of the town and the other over half a mile to the north of the southern outfall.

Both of these outfalls, being very low, are tide-locked at high water, and consequently, when heavy rains have fallen at high tide, the low-lying parts of the town have been flooded and the traffic stopped for the time, the capacity of the sewers being insufficient to afford storage for the rainfall.

With a view to doing away with this flooding, and to arrange for the extension of the drainage system to the increasing numbers of new roads and houses which are being constructed in the district, a Drainage Committee was formed by the Town Council, and this Committee, in 1896, recommended that Mr. Baldwin Latham, M.Inst.C.E., be consulted as to the best means of sewering and disposing of the sewage of the borough.

This course was adopted by the Corporation, and Mr. Baldwin Latham was consulted, who prepared plans, estimate and specification of the new drainage works, which were commenced early in 1899, and will probably be completed in the early part of next year.

The Author is indebted to Mr. Baldwin Latham, who has very kindly lent the drawings of the new sewerage works and has also given other facilities for the description of same.

The area of the district is 1111⅓ acres; and 175 acres the estimated area from which rain-water in the future will be contributed to the sewers.

The population in 1891 was 8891; the rate of increase for the previous decade being 4·6 per cent. The population for the new works is estimated at 11,000, and allowance is also made for 11,000 visitors in the height of the season.

The average rainfall is taken at 30·17 inches per annum, and the rate at which it falls is about ·073 inches per hour.

The estimated volume of dry-weather sewage is 440,000 gallons per day.

From tidal observations it was found that the tide takes about five hours to rise and seven hours to fall, the mean

high-water level being about 7·40 above O.D., and the highest tide recorded 10·17 above O.D.

The flood tide at Deal commences (flowing in a northerly direction) about two hours before high water and flows till about 3½ hours after, when the ebb tide sets in.

The float observations which were made showed that the flood tide set out in a north-easterly direction beyond the ruins of Sandown Castle, at the point where the new outfall will discharge.

At the completion of the new works the sewerage of the borough will still be on the combined system, but the two existing outfalls near the centre of population will not be required; the sewage being conveyed by a new main sewer from the old outfalls northward to a pumping station, which will be established at a point near the municipal north boundary, where the sewage of the whole district, including the undrained areas at Upper and Middle Deal, will gravitate to, and be lifted into, the covered tidal storage reservoir, from whence it will be conveyed, after screening, through the new outfall into the sea.

The erection of a pumping station was found to be necessary in consequence of several parts of the borough being lower than the level of the sea during high tide.

The subject of employing a separate system of drainage for all surface water was considered by Mr. Baldwin Latham, but it was found to be a difficult and expensive undertaking.

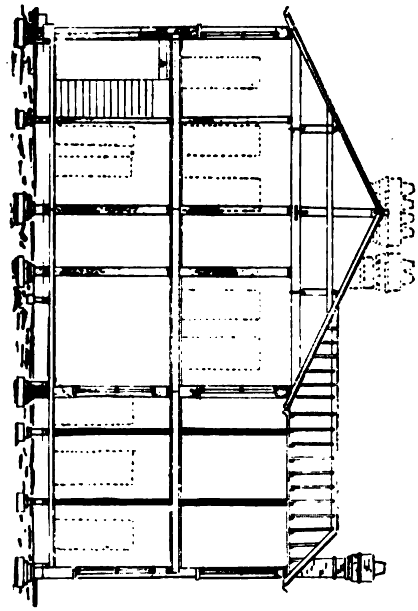
The road water from portions of Upper and Middle Deal (where its discharge is already conveyed away through the natural streams), will not pass into the new drainage system.

The main sewer above referred to commences near Deal Castle with 21-inch pipes with a fall of 1 in 820, and increases to 24 inches with a fall of 1 in 980, after which it becomes a 33-inch brick and concrete sewer with a fall of 1 in 1400 into which runs the drainage from the undrained area; this is increased to 42 inches with a fall of 1 in 2000, and receives the sewage from the old northern outfall, finally reaching the pumping station with a diameter of 45 inches, the fall being 1 in 2250.

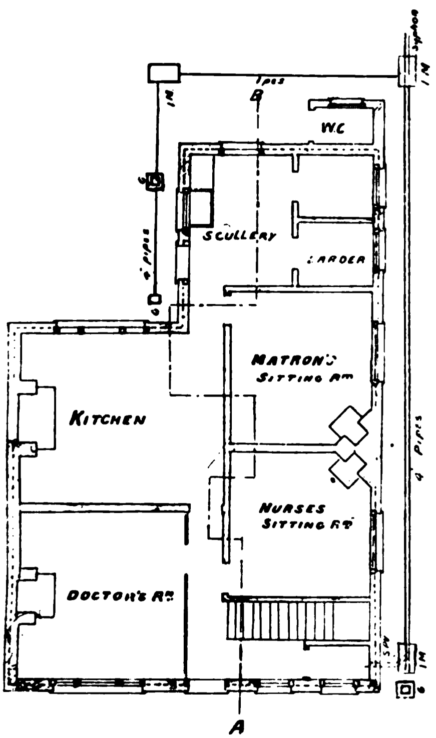
Pipe sewers varying from 8 to 18 inches in diameter and jointed with tarred gasket and Portland cement, have now been laid through the various roads of the undrained area outside the more thickly populated parts of the town.

PLATE I.

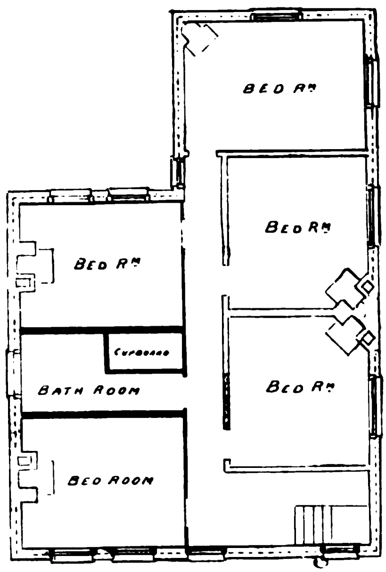
FRONT ELEVATION.



SECTION A B.



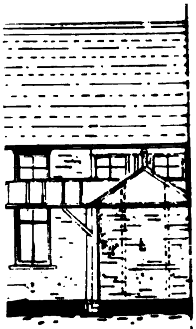
GROUND FLOOR.



FIRST FLOOR.

PROPOSED DEAL, WALMER AND PORT SANITARY HOSPITAL.
ADMINISTRATIVE BLOCK.

PLATE II.



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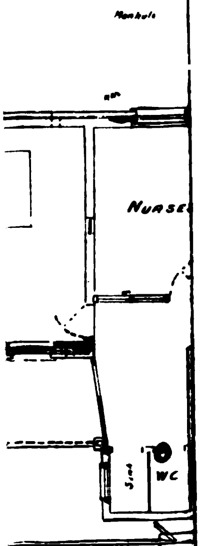
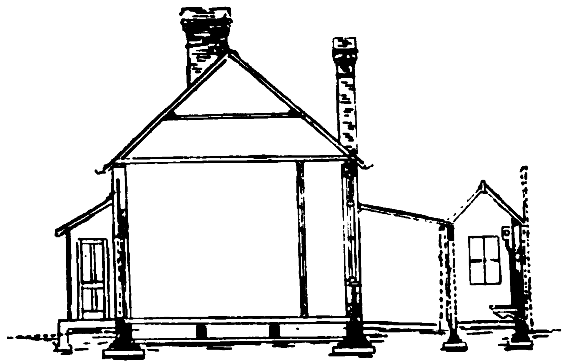
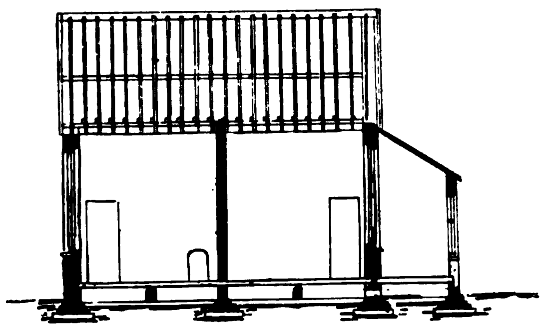




SECTION EF



SECTION C.D

ED DEAL, W

All sewers in trenches over 12 feet deep have been embedded in concrete. Concrete manholes have been put at every change of direction of the sewers.

Flushing Stations.—These have been constructed, fitted with automatic syphons, etc. at various suitable points, such as high ends of sewers. Flushing blocks have also been fixed in the outlets of every manhole in all the pipe sewers.

Ventilation.—Ornamental ventilating shafts or columns (according to circumstances) are to be fixed to all sewers for ventilating purposes.

The contract price for the brick and pipe sewers is 21,139*l.*, and their total length is over nine miles.

The *Cast-Iron Outfall* now being laid seaward from the storage tank is (or will be) 2600 feet long and 27 inches in diameter, and it is to extend 500 feet into the sea from low-water mark. It has a fall of about 1 in 154. The invert level of the end pipe will be 12 feet below O.D. The position is well chosen, the end being opposite the sandhills, 1500 feet to the north of the ruins of Sandown Castle and beyond the municipal boundary of Deal.

The discharge of the sewage is arranged to commence at high water, just as the sea begins to recede, when the flood tide is running at its strongest in a north-easterly direction; and it is estimated that the whole of the sewage will be discharged within two hours of high water.

Turned and bored joints are employed for the first section near the storage tank, and flanged pipes with turned and bored joints for the lower end of the outfall; all the pipes are 12 feet long and weigh about 29 cwt. each. Those pipes which are not entirely embedded in the sea bed are supported on iron bearers secured to 6-inch cast-iron columns or piles, fitted with wrought-iron screws at the feet.

The contract price for the outfall is 4746*l.*

The Covered Reservoir now in the course of construction is situated near the northern extremity of the borough boundary, and is formed of concrete with roof of groined arches supported on concrete columns, and the external walls are backed up by earth slopes. Its size is 81 feet 9 inches square inside, and 13 feet high to the springing of the arches, which have a radius of 4 feet 10½ inches. It has a capacity of about 600,000 gallons, and the level of its floor is nearly 12 feet above O.D. For regu-

lating the discharge two penstock tidal valves are provided at the north-east corner of same.

Ventilators are inserted in the arches forming the roof. The Portland cement concrete in the floor and walls was mixed 6 to 1, and that in the piers, arches and spandrils 5 to 1. The slope of the embankment is 2 to 1.

The storage tank rests on a stratification of about 10 feet in depth of sand, flint and stones, and below this there is a stratum of clay.

The contract price for this reservoir is 3310*l.*

The Pumping Station is situated near the storage reservoir before described, and comprises the engine-house, water-tower and pump-chamber, the latter being constructed of concrete below the ground line, and both the engine and pump house are formed of 14-inch brickwork above the ground, with a slate roof. There will be ornamentel louvres fitted in the roof for ventilation.

The pumping machinery comprises two 25 nominal horse-power Otto gas engines of Crossley's latest type, each driving three single-acting 24½-inch sewage pumps with 3 feet stroke, and raising 530 cubic feet of sewage per minute. They are fitted with clutches and gearing for automatic working, and supplied with hydraulic arrangements for automatically putting the pumps in and out of gear. There are also two 7 nominal horse-power Otto gas engines, each driving three single-acting sewage pumps 13 inches in diameter and 2 feet stroke, raising not less than 100 cubic feet of sewage per minute. There will also be two half horse-power (nominal) Otto gas engines of Crossley's latest vertical type for driving the screening apparatus for the sewage.

There will be two 18-inch and two 10-inch rising mains between the pumping station and the covered reservoir.

The pumping machinery is supplied by Messrs. George Waller and Co. The maximum lift is 25 feet 9 inches, and the minimum lift 13 feet 3 inches.

The contract price for the pumping station, including buildings, pump well, machinery and pumps, is 8659*l.*

The total cost of the works will be about 43,000*l.*, including the amount of the contract, engineering charges, and the purchase of the land and easements.

The total expenditure to date is about 27,000*l.*

The contractor is Mr. Henry Hill, of Maidenhead.

The Case Groynes at Deal.

The Author will leave out the history of sea defence works employed before the introduction of the Case Groynes. To show that the Marina sea wall at the north end was in a precarious state, it will be sufficient to quote the late Mr. Edward Case's statement in his report to the Deal Council, dated June 4, 1898, that since 1872 the high and low water marks have encroached considerably; the former an average of 40 feet and the latter 160 feet.

The work proposed by Mr. Case comprised two sections of groynes, numbering fourteen each, the first being 400 feet long and 200 feet apart, the second varying from 200 to 300 feet in length and spaced 300 feet apart. The Corporation decided to have the first or northern section (which extends from the ruins of Sandown Castle to the Coastguard station, a distance of 2620 feet) carried out by Mr. Case at a cost of 3000*l*.

Work was commenced on August 26, 1898, and was estimated to take three years to complete.

The total length of these groynes is 5600 feet, and a length of over 4000 lineal feet has been erected up to the present. The groynes commenced about 45 feet east of the sea wall, at a shore level of 2 feet above O.D., and were carried down to the low-water mark of spring tides by the end of the first autumn, an average distance of about 150 feet. The work was continued seaward on every favourable low tide, as the sand accumulated by the groynes caused the low-water line to recede; and the average length is now 290 feet.

The principle under which these groynes are employed is the building up of the shore to the natural angle or slope of repose, which takes the form of a quarter of an ellipse (the sharper portion of the curve being of course uppermost) which is really the actual form of the shore after a scouring tide. Where the shore is too steep, or it is desired to push seaward the high-water line, the low-water mark is pushed seaward by the groynes, until the correct proportion between the range of the tide and the distance between high- and low-water marks is obtained by collecting the drift.

The groynes are low and of slight timber, generally not

more than 2 feet above the shore at their highest point. The object of their being low and away from a sea wall or bank is to prevent scouring by obstruction at high water.

Construction of Case Groynes.—They consist of double uprights (2½ inches by 7 inches and 6 feet 6 inches long) with adjustable planking inserted between them. These uprights are let into the shore and set in concrete. The horizontal planks are placed two deep below the shore level, and about three planks high above, the planks being held in position by the ends being inserted between double uprights or piles, and the top pieces are secured by spikes.

The engineers for the "Case Sea Defence Syndicate" rightly claim that the construction of these groynes is very rapid and economical, and that practically no plant of any kind is required. They also claim that since August 1898, a total of 58,678 tons of material have been accumulated by the same, and that low-water mark of ordinary spring tides has receded an average distance of 50 feet.

Before these works were undertaken, the Corporation were often obliged to spend considerable sums not only for repairing damage to the face of the Marina wall, but for underpinning, making good breaches in the same, and repairing the roads near, torn up by the sea And this expense has not been incurred since.

Proposed Deal, Walmer and Port Sanitary Fever Hospital.

The site is freehold and has an area of 2 acres 2 roods and 37 perches, and is situated on high ground at the south-west end of the borough.

Administrative Block.—This will be a two-story building, with a medical officer's room, matron's room, sitting-room, kitchen, scullery, pantry, coal store and two water-closets on the ground floor, and five bedrooms and one bathroom on the first floor.

Ward Block.—The accommodation proposed is eight beds, and comprises two small single bed wards at each end of the block, 16 feet 6 inches by 11 feet 6 inches and 13 feet high ;

adjoining each pair of end wards is a nurses' room 15 feet 6 inches by 14 feet, fitted with white glazed sink and inspection windows in each division wall, and between the two nurses there will be two bed wards, each 24 feet by 18 feet and 13 feet high.

In front of each of the nurses' duty rooms there will be a passage, opposite which will be a bath room with portable bath; there will also be a closet and slop sink situated apart from the nurses' rooms. In front of the centre wards there will be an open verandah with glass roof.

The heating will be by open fires.

The principal means of ventilation will be through the windows, and in addition there will be inlet and outlet ventilators.

Hellyer's corbel washdown closets and Doulton's hospital sinks will be employed at the ward block.

All horizontal and vertical angles will be rounded in this block, and the internal walls will be rendered and finished with Robinson's cement.

The nurses' duty rooms will be fitted with ranges, fitted with boot boilers, etc., for hot-water supply to baths and sinks.

Laundry Block.—This comprises a mortuary, wash-house, drying closet, rooms for disinfecting apparatus, coal store, water-closet, and a spare room.

The Nottingham Patent Steam Disinfector (manufactured by Messrs. Goddard, Massey and Warner), which the town has already in use, will be fixed in the laundry block; and the wash-house and other offices will be fitted up in the usual way.

Drainage.—The drains of all the above buildings will be on the combined system and run into the town sewers; stoneware salt-glazed pipes, partly bedded in concrete, will be employed and laid in straight lines from manhole to manhole. A good fall will be given the pipes, the site having a natural fall in the right direction. All soil pipes will be carried undiminished above the eaves of the roof, and fresh-air inlets will be inserted at suitable points. One intercepting syphon is to be fixed at the lowest manhole of each block of buildings.

The water supply to all blocks will be from the Corporation main.

The Author's estimate of cost is as follows:—

	£
Ward block	2048
Administrative block	857
Laundry block	515
Cost of land	275
Road-making, fencing, furniture, &c.	305
	£4000

Underground Conveniences.

Two underground lavatories have been recently completed at Deal, one called the Broad Street lavatory and the other Marina lavatory, and they were carried out under the Author's directions by contractors.

The former, which is situated in the centre of a road near the pier, is fenced round in the form of an ellipse and planted with shrubs and flowers, has its inside walls composed of best white-glazed bricks with a grey dado about 3 feet high. It has six water-closets, six circular glazed urinals, two slipper bath rooms fitted with hot and cold water supply and lavatory basins, one lavatory with two basins, and one attendant's room, and its cost was just under 1000*l.*

The Marina lavatory is situated near the north end close to the sea, and comprises five closets, six circular-backed marble urinals, one bath-room, one lavatory, with two lavatory basins, and one attendant's room. Hot and cold water is laid on to the bath and lavatory basins. The inside of the building is lined with white glazed bricks with a grey dado. The roof is carried on the walls and girders, and is formed of 3-inch York stone, and pavement lights are fixed to light the various offices. Ventilation is by means of areas with iron gratings over, and window openings in the closets and other parts admit a good supply of fresh air. The drains, which are thoroughly ventilated and trapped, are connected into the town sewers.

Water is supplied from a tank, on the site, and the whole is fenced round and planted with shrubs and flowers. The cost was 880*l.*, exclusive of the cost of the site.

Proposed New Depôt Buildings.

These buildings are as follows:—New stables; a small mortuary; stableman's house; general store, with block-making rooms; water department store; cart sheds.

The stables comprise eight stalls—6 feet between the divisions—one loose box, harness room, place for corn, and at one end there is a hay-loft over the harness room, loose box and two of the stalls.

Blue Staffordshire stable paving bricks will form the floor, which will be drained by open channels discharging outside on to trapped gullies. The stables will be thoroughly lighted by windows, and the ventilation will be by windows, Boyle's air-pump ventilators and air bricks. The space provided per horse is 1155 cubic feet.

The mortuary is but very small, being for only three tables; it is provided with a white glazed sink, has two windows facing the north, and is fitted with a fixed glass screen near one end, so that the bodies can be viewed from outside the screen. The floor and walls of the building will be rendered in cement with trowelled face.

The stableman's house consists of a six-roomed cottage (including the scullery), and is arranged conveniently near the stables.

The general store is a brick building 64 feet long by 18 feet in width and two stories in height.

The water department store consists of a small two-story brick building adjoining the stableman's house.

The cart sheds are about 120 feet long by 15 feet wide, with a galvanised iron roof, and are arranged to hold sixteen carts of different descriptions.

The total estimated cost of these buildings is 2000*l*., including the purchase of the land at 275*l*.

Deal Waterworks.

The works were established in 1840 by a private company; and the undertaking passed into the hands of the Deal and Walmer Joint Authorities about 2½ years ago, the purchase price being about 63,500*l*.

The works are situated on the hill between Upper Deal and Walmer. Water is pumped from wells 115 feet deep in the chalk, into a covered reservoir holding 750,000 gallons, and then gravitates to the various parts of Deal and Walmer.

The works are controlled by "The Deal and Walmer Joint Water Board," formed of members from each council.

The Author appends a copy of the report he received last July from the analyst on the character and composition of the water:—

JENNER INSTITUTE OF PREVENTIVE MEDICINE.

Chairman of Council: Lord Lister, P.R.S.
Hon. Treasurer: Sir Henry E. Roscoe, F.R.S.
Director: Allan Macfadyen, M.D. B.Sc.

Report on Examination of a Sample of Water, 13/7/1900.
Received from Deal on 9/7/1900.

The sample was marked Standpipe, South St., Deal. 9/7/00

General Characteristics.

The sample was clear, of good colour and free from odour.

Analytical Data.

	Parts per 100,000
Suspended matter	..
Dissolved solids	33·2
Chlorine	2·75
Alkalinity expressed as calcium carbonate	20·5
Free and saline ammonia	none
Albumenoid ammonia	0·0016
Nitrogen as nitrites	none
Nitrogen as nitrates	0·63
Oxygen absorbed from permanganate at 80° F.—	
(*a*) 15 minutes	..
(*b*) 4 hours	trace
Injurious metals	none
Permanent hardness	3·7

Remarks.—The sample shows no important difference from that last examined at the Institute, and has all the chemical characteristics of a water of good quality.

(Signed) ARTHUR HARDEN.

JENNER INSTITUTE OF PREVENTIVE MEDICINE.

Chairman of Council: Lord Lister, P.R.S.
Hon. Treasurer: Sir Henry E. Roscoe, F.R.S.
Director: Allan Macfadyen, M.D. B.Sc.

Report on Examination of Sample of Water, *July* 28*th*, 1900.
Received from Deal on July 9th, 1900.

The sample was received packed in ice.

The sample contained on an average 1000 micro-organisms per cubic centimetre capable of development on gelatin at a temperature of 22° C.

Special search for organisms which by their presence might indicate contamination did not result in any such being found.

The results of the examination are consistent with the water being of good quality.

(Signed) SYDNEY ROWLAND.

DISCUSSION.

Mr. W. Weaver: In moving a vote of thanks to Mr. Golder for preparing and submitting this paper for our consideration, I am sure I shall only be voicing the wishes of the Members. As I said at Tonbridge yesterday, it is not the magnitude of the town or of the works we visit that so much impresses the Members as the manner in which the works, in all their details, are carried out. In many small works we often light upon information which is lacking or escapes our attention in works of greater size. It is now, I think, a quarter of a century since I last visited Deal, and if my memory does not play me false, the town has considerably altered in that period. It seems to me it is getting modernised to a considerable extent; the front has been considerably altered since I was here, and I think the whole aspect of the place has been considerably improved. The main feature in Mr. Golder's paper is a description of the groyne work on the foreshore. I think to many of the Members it will be a novelty, as I believe it is the first time we have inspected groyne work done on the Case system. We have inspected many large foreshore undertakings, for instance, Brighton, where groyne work of considerable magnitude has been carried out and has been viewed by the Members of the Association. Of course, the groyne work at Brighton is of a different character and very costly. If the work, as carried out here, will only stand, there is not the slightest doubt that it is a very economical way of dealing with the beach difficulty. It is not only economical, but it prevents the disfigurement of the beach. The ordinary groyne work I think spoils the appearance and to a large extent does away with the full use of the beach. You walk along the foreshore and come to a groyne, and if you wish to continue your walk have to jump down perhaps 6 or 8 feet on to the other side. Then, with all the struts and timbers, the groynes present a very great disfigurement. It has been my lot to stay at times in the neighbouring town of Seaford. Years ago Seaford Bay was one of the prettiest on the Sussex coast, and, as viewed from the cliff, looked like a miniature Bay of Naples. Now it looks more like a collection of clothes props in a drying ground or back yard—the groynes have so entirely altered the character

and look of the place. If at Seaford the same preservation of beach could have been effected by the system adopted here, it would have prevented the very great disfigurement which has taken place there, and saved a large amount of money. Of course the test of the Case system rests in its standing and doing the work it was designed for. If I am correct in what I have read, this system is not an entirely new thing, but has proved itself in other places. I think I remember seeing some photographs in one of the magazines—the 'Strand' or the 'Windsor'—of a number of places where this system of groyning had been adopted, and the effects secured appeared to have been marvellous. At Dimchurch they had secured 8 feet of beach by this system of groyning. If the town authorities of Deal can save their town and beach by the work they have executed here, I am quite sure the inhabitants of the district will be under a debt of gratitude to the designers and to the Council for adopting this system. With regard to the sewerage, of course we shall know more after we have inspected the works. They have been designed by Mr. Baldwin Latham, and I take it that he is a gentleman who knows what he is about, and that they will be successful. I noticed that Mr. Latham has not, on account of the cost, gone in for the separate system—so much in vogue. In a small town, one of the first duties of the Council is to keep the ratio within the paying capabilities of the ratepayers. In some districts the people are getting so sanitary that they can hardly afford to live. I maintain that it is better to have something to live upon during a shorter life than to lengthen your days through a prolonged period of comparative want. I do not gather from the paper whether the Council execute their own work and keep their own horses.

Mr. Golder: We keep the regular staff, about six horses, and the rest we hire.

Mr. W. Weaver: I went into one of the underground lavatories. It is of very neat construction, and it seems to me 1000*l.* is not a large sum to pay for the work that has been carried out there. Of course, you have had no difficulty in dealing with gas and water mains, which entails considerable expense if you are constructing an underground convenience, say, in Holborn. It is a novel point having baths in these underground conveniences. I do not know whether there will be

a demand for baths, especially in a seaside place, but the authorities can better judge on that point than strangers to the town.

Mr. A. E. Nicholls: It gives me great pleasure to second the vote of thanks. There is only one point I should like to ask the Author a question upon, that is with regard to the underground conveniences. I should like to know if Mr. Golder has any record of the income, and also to what extent the baths are used.

Mr. Jones: I notice that Mr. Golder says that the sewage will be conveyed, *after screening*, through the new outfall into the sea. I should like to know if all the solid matter is taken out before discharged into the sea.

The President: Or is it only rough screening?

Mr. Jones: It is a very great consideration where you have a sea outfall, if you have got to dispose of your solids after screening.

Mr. W. N. Blair: There is a statement in the paper about the groynes being kept low down on the beach to prevent scouring at high water. What I ask is this, do you find it unnecessary to provide any protection to that high shingle bank at high-water mark? It would appear to me to be possible, at times of high water and strong winds, for that shingle bank to get moved very considerably or even to be carried away altogether. There is a statement somewhere in the paper to the effect that no protection is necessary. In the ordinary course of things one would expect that with a steep shore as you have here, the effect of the waves would be very much greater than if you had a shallow beach. That does not seem to have been the experience here, and on that point I would like some little explanation. There is another question as to the pumping at the tank. The paper states that the high lift is 25 feet 9 inches and the low lift 13 feet 3 inches. I do not understand how there is a difference. Surely the suction of the pump, or the level from which the pump is drawing is constant, and the delivery level of the pump I take in the ordinary course of things to be a fixed level. Therefore I do not know why there should be two levels. The paper brings before us several points of interest which will be useful for reference. The references we can make to our annual volumes are frequently of the greatest value to us.

Mr. Knight: Having been to the new convenience, which I understand was only opened in July, I am pleased to notice that

a suggestion of my own has been adopted. It was a suggestion I made to Messrs. Doulton when doing similar work for me, that is, to get the bottom of the half-round urinals in one piece. In your case they have succeeded in doing it; I desired it, because the joint made it very difficult to keep clean and nice. In any future work I shall now see that it is strictly carried out. As to the baths in the conveniences, I think it a very good idea, and I have no doubt it will pay its way. After a sea bath you feel sticky, and bathers will probably avail themselves of the opportunity of a fresh-water bath. These places generally do pay, but in the winter time it is a matter of considerable doubt whether it will pay here.

Mr. E. Willis: There are one or two matters in the paper upon which I should be glad to have information. The cost of the cast-iron outfall through the cliffs into the sea struck me as being very moderate if there is much tunnelling or diving required, as usually happens in works of this kind. Perhaps the Author would inform us what is the nature of work anticipated, and whether much diving and tunnelling will be necessary. I notice that gas seems to be a usual motive power for pumping in this neighbourhood. Is it due to any difficulty in obtaining suitable steam coal at reasonable prices, or has it been found to work more economically than steam even though the price of gas may be high? With reference to the provision of baths in the two public conveniences, a luxury which I have seen here for the first time, I should be glad to know if they are remunerative, and whether the income is greater from the ordinary or the slipper baths. In the particulars given of the water-works I notice the supply is drawn from the chalk. It would be useful to know how many adits (if any) are driven from the well, and their size and length; also whether it has been found necessary to increase them to keep pace with the supply required. I should like to include my thanks with those of the gentlemen who have already spoken, to the Author for his useful and interesting contribution to the 'Proceedings' of the Association.

Mr. A. H. Campbell: I should like to ask as to the population to be served by the Infectious Hospital. As I see there is only provision in the hospital for some eight beds, I should like to know what relation that bears to per thousand of the population. It is a very small provision, and you cannot provide for separation of sexes and of different diseases. With respect

to the provision of pumping power for the lifting of the sewage into the storage tank, I expected to see some reference in the paper to the scavenging of the district, what quantity of refuse is collected and how disposed of, and whether the utilisation of the heat from a proper destructor could not have been applied to the raising of the sewage to the tank, and so save the expense of gas, however cheap and economical it may be.

A vote of thanks to Mr. Golder for his paper having been accorded by acclamation,

Mr. Golder, in reply, said: I am not sure whether I can give full particulars in reply to every one of the questions which have been put, however, I will give what I can, and will be pleased to furnish any fuller description if necessary. First, Mr. Nicholls asked as to the income of the underground conveniences and to what extent the baths are used. I cannot give you exact details, but approximately the income up to the present time has about paid the interest on the outlay but not the repayment of loan, that is to say, about half the yearly working expenses and repayments of loan. The baths at the south end lavatory have been very much appreciated and well used. I cannot tell you how many have been taken daily, because it varies according to the weather and the number of people on the sea-front, but in summer time I should think the average would be upwards of twelve baths in a day, and there being only two baths, that is pretty fair, but of course a great portion of the year the baths will be but little used. They have only been opened this summer, so I am unable to give you any experience of the winter. The next question was by Mr. Jones, as to screening the sewage, whether the solids are removed or only rough screening. Only rough screening will be done, the solids will not be removed, only paper and other things like that, so as to prevent anything floating on the water when discharged. The next was Mr. Blair's question as to the position of the groynes in relation to the sea-wall. As the work is not completed yet, it having only been commenced about two years ago, and the time estimated being three years, I cannot say what will be the ultimate result. The idea of Mr. Case, who was consulted in regard to this, was, that to carry groynes up to a sea-wall is a mistake and causes a scour at the foot, and thereby prevents accumulation of drift at the foot of the sea-wall where it is required. Mr. Case's recommendations have been carried out and

have so far been successful. For my own part I do not agree with the idea of a good many engineers, that it is necessary to carry groynes right up to the sea-wall. What I have seen in many places has been high groynes carried up to the wall and the beach has been collected on the one side and scoured away on the other, to a depth of seven or eight feet, as is the case at Seabrook. That can hardly be desirable. The result of this scour is that every now and then the wall is carried away. Mr. Case was entirely opposed to the idea of the groyne being carried up to the sea-wall because it caused scouring. Mr. Willis spoke with regard to the small cost of the outfall. Of course that is a tender. I am not able to judge yet as the work is not completed. The outfall has so far been carried down to low-water mark. There has been no tunnelling, it having been all open cutting, nor has there been any diving so far, but very likely we shall see some carried out before it is finished, as the invert of the lowest pipe is something like twelve feet below Ordnance datum. As to the gas engines and the matter of utilising the house refuse, Mr. Baldwin Latham was called in, and no doubt his ideas are correct. The town were not anxious to go in for anything else because of the nuisance caused by a tall chimney giving off volumes of black smoke, and the difference in cost was very small. It was not considered desirable to destroy the refuse in that way, because we got rid of it by selling to farmers at a very fair price. With regard to Mr. Campbell's question as to the hospital and the accommodation provided, I am aware that the number of beds is not in accordance with the requirements of the Local Government Board of one bed per thousand of population; but it has been thought by the joint authorities of Deal and Walmer that eight beds would be sufficient, and the Local Government Board have provisionally given their sanction, subject to the drainage being satisfactory. When the matter was brought before the Local Government Board the new drainage works were not completed, and, as a matter of fact, the drainage in that part of the town is not completed yet, so it was impossible to build the hospital until we had extended our system of sewers. I should like to thank all the Members warmly for the very kind way in which they have received my paper. If the information given in it is to your advantage I am very pleased, for I consider it to be the duty of every Member of the Association to offer what information he can so that it

may be diffused as widely as possible. Again I thank you very much for the kind way in which you have received my paper.

Prior to the reading of the paper by Mr. Golder, the Members visited the Case groynes at the north end of Deal. Immediately following the business proceedings the Members were entertained to luncheon in the Town Hall by the Mayor and Members of the Corporation. The afternoon was devoted to inspections of the sewage works, including the storage tanks, and the Water-works.

DISTRICT MEETING AT EAST MOLESEY AND HAMPTON-ON-THAMES.

October 6, 1900.

Held at the Castle Hotel, East Molesey.

E. GEORGE MAWBEY, M. INST. C.E., PRESIDENT, *in the Chair.*

Mr. H. J. ROBERTSON, J.P., the Chairman of the East and West Molesey Urban District Council, offered the Members a very hearty welcome to the district, in which the Chairman of the Hampton-on-Thames District Council, Mr. George Sanders, J.P., heartily joined.

Mr. Mawbey thanked these gentlemen for the kind welcome they offered.

The following papers were read and discussed:—

SOME OF THE PUBLIC WORKS IN EAST MOLESEY.

By JOHN STEVENSON, ENGINEER AND SURVEYOR TO THE URBAN DISTRICT COUNCIL.

IT is with hesitation that the Members of the Association are welcomed to East Molesey, for whilst we feel honoured by the visit, we know that it is not usual for the Association to meet in so small a town. But it is hoped that though the works are not very extensive they may be of interest to the Association. East Molesey is perhaps best known for its regatta, which is undoubtedly second to none on the Thames, besides being the

locality selected for the intakes of the Lambeth, and also the Chelsea Water Companies. In the district and neighbourhood are three important racecourses. It is also a favoured residential district, and undoubtedly possesses natural advantages which add to its beauty and assist in making the locality a favourite resort during the spring and summer months.

Statistics.

East Molesey was constituted an Urban District in 1866; in October 1895 the district was extended and West Molesey was added.

Population	7,820
Rateable value	£51,913
Area (acres)	1,518

The above statistics are for the present time and for the whole district.

Sewerage.

The East Molesey ward was sewered in 1893 to 1895, Mr. J. C. Melliss, M.Inst.C.E., being the engineer. The high level portion, comprising quite three-fourths the area of the district, gravitates to the disposal works where the sewage is pumped from a deep pump well into the precipitating tanks. There are also two Shone's ejector stations, for raising the sewage from the low-level areas of the district, which is lifted into the high-level system. The Author made many suggestions for improving the scheme, which undoubtedly rendered it more efficient as well as resulting in greater economy both in capital cost and working expenses. He was also engaged as "resident engineer" by the Authority, quite apart from the engineer and his inspectors, to supervise the construction of the works; and it is a special feature of this scheme, that it is one of the best and most watertight schemes that have been carried out in the Thames valley, and up to the present time the sewers have worked in an excellent manner.

Many extensions, some in difficult ground, have been carried out by the Author, since the completion of the general scheme. Some have been carried out by contract, and some departmentally.

There are 8 miles of main sewers, varying from 9 inches to 15 inches in diameter.

The Authority laid all branch drains from the main sewers to the boundaries of all the existing premises requiring drainage, this work being done at the Authority's expense out of Loan Account. All connections with the sewers for new houses and branch drains, on the public and also the undedicated roads, as far as the boundary of the properties, are carried out by the Council's staff, at the expense of the persons requiring them. This ensures watertight work, which is very essential, and especially in ground containing large quantities of subsoil water.

SEWAGE DISPOSAL.

The sewage, on being received at the works, is precipitated in tanks, sulphate of alumina and lime being used in the treatment, and occasionally sulphate of iron when the sewage is of a strong character, and atmospheric conditions very high. The supernatant water is then passed on to the land and dealt with by intermittent downward filtration. In consequence of the carriers first put down for conveying the clarified water on to the land having been constructed at a useless level, the Author has had to lay other carriers at a higher level so as to command the land in a proper manner; he has also had to lay many additional land drains and materially improve the filtration area, and suitably adapt it to the purpose for which it was required.

Under the surface soil is a stiff clay, varying from 1 foot 9 inches, to 2 feet 6 inches in thickness, and it has been imperative that this should be broken through, additional drainage provided, the soil lightened and the land levelled to a suitable level, in order that stagnation on the surface should be avoided and a proper effluent obtained. The drains were laid at depths varying from 4 feet 9 inches to 6 feet 6 inches deep. Socket pipes have been used and surrounded with coarse ballast or screened clinker from the burnt house refuse, and it is found that this does not allow the effluent to pass through too quickly, the effluent being of a very good character.

The house refuse collected in the district during the past four years has been used in lightening and levelling the ground and improving the filtration area. This is all properly selected and

screened upon its arrival at the works, the decaying vegetable and other matter burned; this is then screened, and the clinker screened, broken and placed around the land drain pipes.

The land drains were laid in parallel lines, and the furrows which distribute the clarified water from the carriers on to the land are parallel with the drains, but kept at sufficient distance from drains so as to pass through sufficient filtrate before passing into the drains, every care being taken that the furrows are not too near the drains.

The obtaining of a good effluent being of vital importance in this district, this is of first consideration coupled with the carrying on of the works so as not to be any nuisance, the cropping coming next in importance.

Osiers, rye-grass, mangold wurtzel and cabbages have been grown on the land, excellent crops having been obtained. The estimated population draining to these works is 6000.

The sludge from the precipitating tanks is pressed into cake and disposed of to local farmers.

The average dry-weather flow is 22½ gallons per head per day.

The cost of the main sewerage scheme and sewage disposal works has been 37,250*l.*

House Drainage.

The connections of house drainage and their reconstruction have been carried out under regulations, and the water test applied; great care is also exercised in excluding the rainfall from the sewers.

Surface Water Drainage.

The Author has designed and carried out a separate system of main surface water drains in the district, these varying from 6 inches to 21 inches in diameter. There are 6¾ miles of these drains including those laid in making up private streets. The whole has been carried out at a cost of 4600*l.*: this includes 309 new gullies, and 960 provisional junctions left on the main drains to receive future connections.

Streets and Roads.

There are 10½ miles of district roads in the district, and not any main roads excepting three county bridges and their approaches. It is a remarkable fact that although we have the county bridges referred to, yet the road between them, which is of a main road character, is not a main road, neither is it an assisted road. We have five roads of a main road character, regarding which we have on several occasions taken the census of traffic passing over them, and have proved that 66 per cent. was foreign traffic; yet the Surrey County Council on each application refused to give any contribution towards the cost of their repair and maintenance.

Recently a new footbridge was erected over "the river Ember," to replace a dilapidated wooden bridge by a water splash on an important main thoroughfare yet; in this case the County Council declined to render any assistance towards its construction, the cost of which was 300*l.* The Author would be glad of suggestions that might have weight with the County Council in a further application to them for a reconsideration of our claim for assistance towards the cost of repairing and maintaining the roads referred to.

Footpaths.

During the past two years many of the footpaths on subsidiary roads have been paved with Derbyshire limestone asphalt. The asphalt is laid 2 inches thick, when finished rolling, consisting of 1 inch bottoms, 1½ inches thick, and finished with a top layer ½ inch thick of ¼ inch toppings, and is laid upon a cement concrete foundation 1½ inches thick. This makes a good sound and pleasing footpath, clean and dry in all seasons of the year. The old kerbstones were taken up and relaid to suitable lines and gradients on a concrete foundation, and a granolithic channel, 8 inches wide with a 4-inch granite cube set on its outer edge, thus making a durable and economical channel. 2600*l.* has been expended on this work during the time mentioned.

In the principal streets, the footpaths on one side have been paved with blue Staffordshire paving bricks, but footpaths recently paved in important parts, have been paved with granolithic paving laid *in situ.*

Water Supply.

The district is supplied with water by the Lambeth Water Company: in very few cases is the water supply taken from wells.

Gas Supply.

The district is supplied with gas by the Hampton Court Gas Company. The price has been 3*s.* 4*d.* per 1000 feet, but notice has recently been given for an increase to 3*s.* 8*d.* per 1000 feet, owing to the increased price of coal and labour.

Public Lighting.

The present street lighting is carried out by oil lamps, which may be regarded as a very primitive method. The Council are at the present time considering proposals for improving the present method by either incandescent gas lighting or electric lighting. There are 187 lamps of various sizes, the average cost being 2*l.* 17*s.* 11*d.* per lamp per annum, burning from sunset to sunrise, including repairs, renewals and all incidental expenses.

Fire Brigade.

The district is provided with an efficient volunteer fire brigade, under the control of the Council. A manual engine and fire escape were provided by public subscription. The brigade have also a hose reel cart, stand pipes, etc. The maximum pressure in the water mains is 70 lb. per square inch. The fire engine station is at the depôt adjoining the Council Offices.

Dust Removal.

The Council do the scavenging of the district with their own cart, appliances and collector, the horses and drivers only being provided by a contractor. This is found to be done far more satisfactorily than when it was done by a contractor. Trade refuse is not removed. The collections are fortnightly, except the large hotels, which are weekly. The refuse is disposed of as previously described, in improving the filtration area at the sewage farm, where it is screened and burnt upon its arrival. The annual collection is 1850 cube yards.

Miscellaneous.

There are two small cemeteries in the district, one for each parish, which are adjoining each other. The Council are the burial board.

There is no school board for East Moseley parish, the national schools providing sufficient accommodation. There is a school board for West Molesey parish, which was established in 1880. There are no other public elementary schools in the district. We have as yet no recreation ground in the district: no doubt as the population increases some provision in this direction will require to be made for the rising generation.

DISCUSSION.

Mr. A. M. Fowler: The paper before us deals with a system of sewage treatment by downward intermittent filtration, and so far as one can tell from the paper is quite up to date. Though we may have bacteria and other schemes of sewage disposal they are as yet untried, while we know that precipitation and downward intermittent filtration are the principles upon which the Local Government Board pin their faith; and until such time as the Royal Commission issue their report we must take it that that is the best system of sewage disposal before the country. I am glad that the district has obtained such good results; and to note that there is a system of surface-water drainage separate from the sewers.

Mr. A. H. Campbell: I should like to ask Mr. Stevenson the cost of a granolithic channel, such as he describes in the paper, what is its durability, and whether he has had any trouble with it, by traffic cutting into it and disfiguring or damaging it. Then the formation of the asphalt pavement is interesting, and I would like to know the cost of it, including the foundation of concrete.

Mr. W. H. Savage: I should like to ask a question with respect to the roads and the attitude of the County Council. Mr. Stevenson regrets that the County Council are not more liberal towards the district. I should like to ask whether the Local Authority have asked for the roads to be made main roads, or simply asked for a contribution towards their maintenance. It

is not usual for counties to contribute to "other" roads, but they often declare roads to be main roads when the circumstances and traffic warrant it.

Mr. J. A. ANGELL: I should be obliged if Mr. Stevenson would inform me what is the depth of the subsoil water throughout the district, the Ordnance level of the works, and of the district generally. I ask this because it is stated that the subsoil water was at one time a foot below the surface of the ground, and I am wondering whether the shallow depth of the subsoil water has rendered the system of downward intermittent filtration a difficult one. I understand that some portion of the solid sewage refuse is burnt on the ground, and it would be interesting to know whether any nuisance arises therefrom, and how far distant the burning takes place from the nearest houses. I should also be glad to know whether any difficulty is experienced at Hampton in summer, or in times of drought, with the water supply. At Beckenham, situate some 17 to 20 miles from the Lambeth Water Company's intakes, almost every summer during which any slightly prolonged hot weather occurs, shortness of water results. This year, for instance, we were compelled to cease road watering for a period, to issue notices cautioning householders of a shortness of supply, and generally were put to much inconvenience owing to the failure of supply. My object in putting this question is to ascertain whether you at Hampton, situate so near to the source of supply, suffer equally with us at Beckenham, or whether our sufferings are due to the fact that two or three valleys lie between us and the Lambeth Water Company's intakes; or, in other words, whether the failure is local and due to insufficiency of pressure and means of distribution, or from failure of supply throughout the Company's district generally.

Mr. C. J. JENKINS: I should like to ask the depth of the sewers, and of the surface-water drains, and the joints used to make them water-tight. I should like to know the price obtained for the sludge—is it given away or sold?

Mr. A. C. JAMES: I should like to ask Mr. Stevenson whether he has taken any gauge of the water delivered by the surface-water sewers.

Mr. T. R. SMITH: I should like to know whether the surface-water drains take the water from the back roofs and yards of houses as well as from the streets?

Mr. G. F. Carter: Mr. Stevenson says that under the surface soil is a stiff clay which it has been imperative should be broken through. I should like to ask what he has done to break through it other than stated in the paper.

Mr. W. N. Blair: The question has not been asked yet as to what distance apart the under drainage is laid out on the filtration ground. I should also like to know, with reference to the ashes which are spoken of as being used to lighten the soil, whether the soil is turned over to the full depth of 2 feet 6 inches or whether only a portion of the soil is turned over.

Mr. E. R. Capon: I should like to ask Mr. Stevenson whether the cultivation of the farm is a financial success.

Mr. W. Weaver: We all know that sludge pressing is an expensive process; and I note that a lot of the refuse is got rid of on the filtration area. I think it fair to assume that the filtration area will not go on receiving that refuse for all time. The question is whether some of that refuse could not be mixed with the sludge and sold to farmers in the district as manure. I have a good many requests from this district for manure, and the question is whether you could not mix your sludge with the ashes and get rid of the cost of pressing.

Mr. Stevenson, in reply, said: A question was asked with respect to the sewers as to how we got them so water-tight. I may say the water test was applied to all main sewers, and I insisted that we should have that test applied up to the maximum level of the subsoil water. The deep sewers were in iron pipes and the shallow sewers in stoneware, and the stoneware pipes were surrounded with cement concrete when below subsoil-water level. The efficient supervision carried out by the engineer's inspectors conjointly with myself added to the water-tightness of the sewers, which I may say will compare favourably with any carried out in the Thames Valley. The pipes used are of three classes, Doulton's self-adjusting, Hassall's single lined and Hassall's double lined.

A Member: Which do you think the best?

Mr. Stevenson: I prefer the Hassall double lined. The Doulton's were very good, but though the Hassall is slightly dearer I think it is the better joint. We have had some of the granolithic channels laid for two years, and I find they are not affected by the frost, but have not used it where traffic is heavy. The asphalt paving is laid at the present time,

including administration and incidental expenses, at 2*s*. 3*d*. per super yard; some of it has cost 2*s*. 4*d*., but the bulk has been laid at 2*s*. 3*d*. per yard. As to the applications to the County Council, we have made three applications for assistance for roads of main road character, but the County Council appeared to consider that East Molesey leads to nowhere and really was a place of no importance. But when we had a record taken of the traffic using the roads, checked by a traffic checker of the County Council, and it was found that 66 per cent. was foreign traffic, the Committee recommended we should have assistance for four out of the five roads asked for by the Local Authority. I am sorry to say that recommendation was thrown out by the County Council, and we have had no assistance except for three county bridges and their approaches. Dealing with the queries of Mr. Angell, the depth of subsoil water varies throughout the district in the wet seasons, the maximum being 2 feet 6 inches and 3 feet below the ground surface. The greater portion of the outfall sewer across private lands is subject to flooding. The Ordnance level of the district varies from 19·25 to 36·20 above Ordnance datum; and on the point as to the effect which subsoil water had on the treatment of the sewage, a large leakage of this water would have involved a considerable additional expense in respect of the annual maintenace expenses for pumping and as a result of the additional wear and tear on machinery. A decrease in the pressure of water is experienced during the hot summer months and in periods of drought. As to Mr. Jenkins' questions, the sewers are laid at depths varying from 5 feet to 24 feet below the ground surface. The actual leakage into the system is inappreciable, especially having regard to the very water-logged nature of the district. I have been able to dispose of all the sludge cake which the works have produced at prices varying from 1*s*. to 3*d*. per one-horse cart load. In response to Mr. James, I have to say that the surface-water sewers deal with the rainfall from the backs of houses as well as from the roads. In plans of new houses separate surface-water drains are enforced. In answer to Mr. Capon, in consequence of the improvements which have had to be carried out to the filtration area to avoid a serious nuisance, as well as satisfactorily deal with the clarified water, the cultivation of the farm up to the end of last year cannot be regarded as a

financial success, but this year I have every reason to believe that it will be remunerative, owing to the manner in which the land has been improved. Referring to the remarks of Mr. Weaver, I may add that the quantity of house refuse, after selection, screening and burning, may be computed at 1550 cube yards per annum, this amount being disposed of in the filtration area. Some two years ago I considered the question of screening the house refuse and mixings with the unpressed sludge, for subsequent disposal to the local farmers, but as the ashes, etc., were required for the improvement of the filtration area this was not put into practical effect; and I am also of opinion that in Molesey such a scheme could not be made financially successful.

SEWERAGE AND SEWAGE DISPOSAL WORKS AT HAMPTON-ON-THAMES.

WITH REFERENCE PARTICULARLY TO THE SHONE SYSTEM OF COLLECTING AND DELIVERING THE SEWAGE, THE CONSTRUCTION OF THE WORKS DEPARTMENTALLY, AND TO THE WORKING OF THE BACTERIAL METHOD OF TREATMENT BY TRIPLE CONTACT.

By J. KEMP, Assoc. M. Inst. C.E., Surveyor to the Urban District Council, Hampton.

The Author in this paper proposes to give, as concisely as possible, an account and description of the construction of the Sewerage and Sewage Disposal of Hampton, and of the working of the Bacteria beds since their completion on December 8, 1898.

Hampton is comparatively a small place, and its population has not increased as rapidly as one would expect, seeing that it is only thirteen miles from London, and has many attractions, including the Thames, Bushy Park and Hampton Court Palace. It has also three stations on the London and South Western Railway system.

The Author attributes this slow increase almost entirely to the want of an efficient system of drainage, as until December 8, 1898, the district had nothing but a cesspool system. From about that date, however, building operations have greatly increased, and there are everywhere signs of a rapid development in the near future.

Another drawback to the development of the district was the level of the ground water, which in winter rose to within 9 or 12 inches of the surface, and could be found at 2½ feet even in summer.

This condition obtained in seven-eighths of the whole area of the district.

The following figures show the rate of increase, both in population and rateable value:—

The population in	.. .. ..	1861	was 3361
„ „	.. .. ..	1871	„ 3915
„ „	.. .. ..	1881	„ 4776
„ „	.. .. ..	1891	„ 5882
„ „	(estimated)	1900	„ 7500

Rateable Value.

	£		£
1890	58,759	1896	63,709
1891	59,852	1897	68,092
1892	60,174	1898	69,513
1893	60,152	1899	74,087
1894	60,562	1900	81,812
1895	63,294		

The death rate last year was 11·4 per 1000.

Owing to the conditions before mentioned it became evident to the Author that any scheme of sewerage should be accompanied by a scheme for the permanent lowering of the subsoil water also, if the full benefit of drainage were to be reaped by the inhabitants, and this was kept in view during the preparation of the scheme.

The Author also recommended the construction of surface water sewers concurrently with the construction of the soil sewers in those roads not already so provided, or where such were dilapidated and useless. This was done in order to, as far as possible, exclude all rain water, not only from roads, but from yards and roofs also, and thus minimise the quantity of sewage to be lifted and treated.

Hampton possesses $2\frac{1}{3}$ miles of river frontage between Hampton Court Palace and Sunbury, and the district measures from north to south 4300 yards. The ground level adjoining the river at the eastern and western extremities of the parish, viz. at Hampton Court and at the Sunbury boundary, is exactly the same, viz. 26 feet above O.D. The summer water level at Hampton Court is 15·50, and at Sunbury 21·50 above O.D., a lock and weir intervening.

About nine-tenths of the district is situate at an elevation of from 55 to 65 feet above O.D., or from 33·50 to 43·50 feet above the summer water level of the Thames; the remaining portion adjoining the Thames varies from 26 feet to 55 feet

above O.D.; so that, for the Thames valley, Hampton lies comparatively high.

A large proportion of the river frontage is occupied by the Southwark and Vauxhall, West Middlesex and Grand Junction Water Companies, whose works and intakes are at Hampton; the remainder is occupied by high class residences, public pleasure grounds and Hampton Court Palace.

Taking the foregoing figures and facts into consideration, it at once became apparent to the Author that the sewage must be pumped and that the site of the disposal works must be inland, away from the Thames and the water companies' intakes, and thus in the highest part of the district.

The first point the Author had to consider in connection with the scheme was the method of collecting and delivering the sewage at the outfall, and, after duly considering the geographical configuration and contour of the district, he came to the conclusion that it was an ideal one for the application of the Shone system in its entirety. He had no hesitation in recommending this, having had previous experience of the satisfactory working of ejectors at Haverhill, Suffolk.

The advantages that the Author foresaw could be obtained by the adoption of this system were (1) The construction of comparatively shallow sewers with the inverts of the outlets sufficiently elevated to admit of the ground water in the greater part of the district being drawn off during construction below the sewer invert by gravitation and discharged into the Thames and into the deep cutting of the London and South-Western Railway, which runs almost through the centre of the district. The cost of constant pumping to clear the trenches, and the inconvenience of pumping plant working in the streets, would be entirely done away with in the construction of all sewers contributing to ejector stations Nos. 1, 1*a*, 2, 4 and 5.

2. The saving in cost as against the cost of the construction of deep sewers in water-logged ground.

3. The facility of laying the sewers so as to be watertight, and of constructing beneath the same subsoil drains with free outlets so as to permanently lower the subsoil water, and so reduce the chance of infiltration of the same into the sewers.

4. That it would not be necessary to erect a pumping station somewhere near the Thames with storage tanks, pump well, screening chamber, etc.

The site procured for the outfall works, practically the only site obtainable, is situated near the north-west boundary of the district, 62·00 feet above O.D. It would therefore have been absurd to have attempted to carry the sewage there by gravitation, as, in addition to having to contend with ground water, the sewer at the outfall would have been something like 100 feet deep. It would have been equally objectionable, costly and difficult to have established a pumping station anywhere in the lower part of the district adjoining the Thames. In which case a nuisance would probably have been created instead of remedied, and the trouble and cost not only from ground water but from Thames water would have been very great indeed during construction.

The Council accepted this scheme, and also directed that it should be submitted to Messrs. Shone and Ault, who approved the same, and were appointed consulting engineers and associated with the Author throughout the works.

The scheme as designed and executed is practically as follows:—

The district is divided into eight areas, in each of which at the lowest point an ejector station is constructed, containing automatic ejectors in duplicate, each ejector being estimated of sufficient capacity to discharge the whole of the sewage from the contributing area when fully built upon. These stations are shown and numbered 1 to 7 on the general map of the district. The sewers and ejectors are capable of receiving and discharging the sewage of a total population of 20,000 persons, reckoning the maximum discharge to be equal to 50 gallons per head per day.

The power at present provided in duplicate is, however, only intended to deal with the sewage of a population of 7500, or a gross total of 15,000 on the above-named basis. This power consists of two 15 nominal horse-power steam engine air-compressors, each air-compressing cylinder being driven direct from the tail-rod of the steam cylinder. The steam cylinders are 12 inches diameter by 18 inches stroke, and the air-compressing cylinders 15 inches diameter by 18 inches stroke. Each engine is provided with a surface condenser with air and circulating pumps, and is capable of ejecting the sewage of 7500 people, reckoning the discharge equal to 50 gallons per head per day.

The boilers are two in number, of the dry-back semi-marine type, each 7 feet diameter and 7 feet long.

The numbers, sizes, positions of various ejector stations and other data are given in Table A, which also shows how the sewage is forced from the ejector stations to the outfall. The tables also indicate the material of which the ejector stations are built.

The sewers gravitating to the several stations are mainly 7 inches in diameter with 5-inch branches for house connections. With the exception of about 2 miles they are constructed with "Hassall's" patent pipes, the remaining length is made up of "Wakefield's" patent, and about 80 yards of cast-iron pipes.

The sewers are all laid on a concrete bed which practically forms an arch over the subsoil drain. The subsoil drains are constructed of 4 and 6-inch butt-joint land·drain-pipes filled up with screened stone on each side to the level of the top of the pipe. The construction is shown in section on Drawing No. 1. Where the excavation passed through the gravel into the London clay, vertical ducts were formed from the gravel bed and connected to the subsoil drain. It may be mentioned here that the subsoil consists of a bed of gravel, varying from 6 to 12 feet thick, overlying the London clay; the crust is a stiff clayey loam varying from 18 to 30 inches in thickness.

The sewers have gradients varying from 1 in 150 to 1 in 250, and at the head of each is placed one of Adams' automatic flushing apparatus; some of these discharge once in 24 hours, and others once in 48 hours according to the length and gradient of the sewer; the capacity varies from 150 to 250 gallons.

Manholes having close covers are fixed about 125 yards apart on the average, and at the head of each sewer is an inlet air shaft. At each ejector station is an exhaust air shaft connected with the contributory sewers. The exhaust air from the ejectors passes through a small pipe into, and up this shaft, creating a current through the inlet pipe at the head of the sewers.

The effluent water drain, 15 inches in diameter, is 3·15 miles in length, and discharges under summer water level into the Thames below Hampton Court Palace.

The length of cast-iron air mains is 3·67 miles, varying in diameter from 3 to 7 inches.

The length of cast-iron rising mains is 3·26 miles, varying in diameter from 7 to 16 inches.

The total length of sewers is 13·33 miles.

Disposal Works.

Before giving particulars as to these works the Author wishes to point out that the scheme of disposal sanctioned by the Local Government Board was that known as the "International," with the usual requirement as to subsequent passing of the effluent over land. Ten acres were deemed sufficient by the Local Government Board for a population of 20,000. The Council, to avoid severance, purchased the present site of 20 acres at 175*l.* per acre. Before the works at the disposal site were commenced, however, the Author heard of the Sutton experiments with bacteria beds, and paid several visits there, being kindly shown over the works by Mr. Greatorex in the first instance, and later by his successor, Mr. Chambers Smith. He was so favourably impressed that he induced his Council to send a deputation there, who were accompanied by Messrs. Shone and Ault. All were of opinion that this method of treatment ought to be adopted.

The Council passed a resolution accordingly, authorising this departure from the original scheme, and for the necessary plans to be made and the work proceeded with. The sanction of the Local Government Board to this departure, however, had not been obtained or sought, nor was it until the beds were nearly completed that they discovered the alteration.

This occurred on the Council's application for further money to complete the works which had exceeded the estimated cost. The Council received a severe lecture, and the Board's refusal to grant any further sanction unless they would agree to lift the effluent from the third contact bed and pass it over land.

The Council had no alternative but to agree to what they considered useless expenditure, and subsequent experience has proved that they were right, as the final effluent from the beds is and always has been of a very good and uniform quality, and satisfactory to the Thames Conservancy.

The effluent water is used for condensing, feed, and cooling purposes, with no ill effects on the boilers in the shape of incrustation; in fact, it is the only water on the works.

Buildings.

The buildings consist of engine house, boiler house, chimney shaft, coal store, workshop, office, and men's mess rooms.

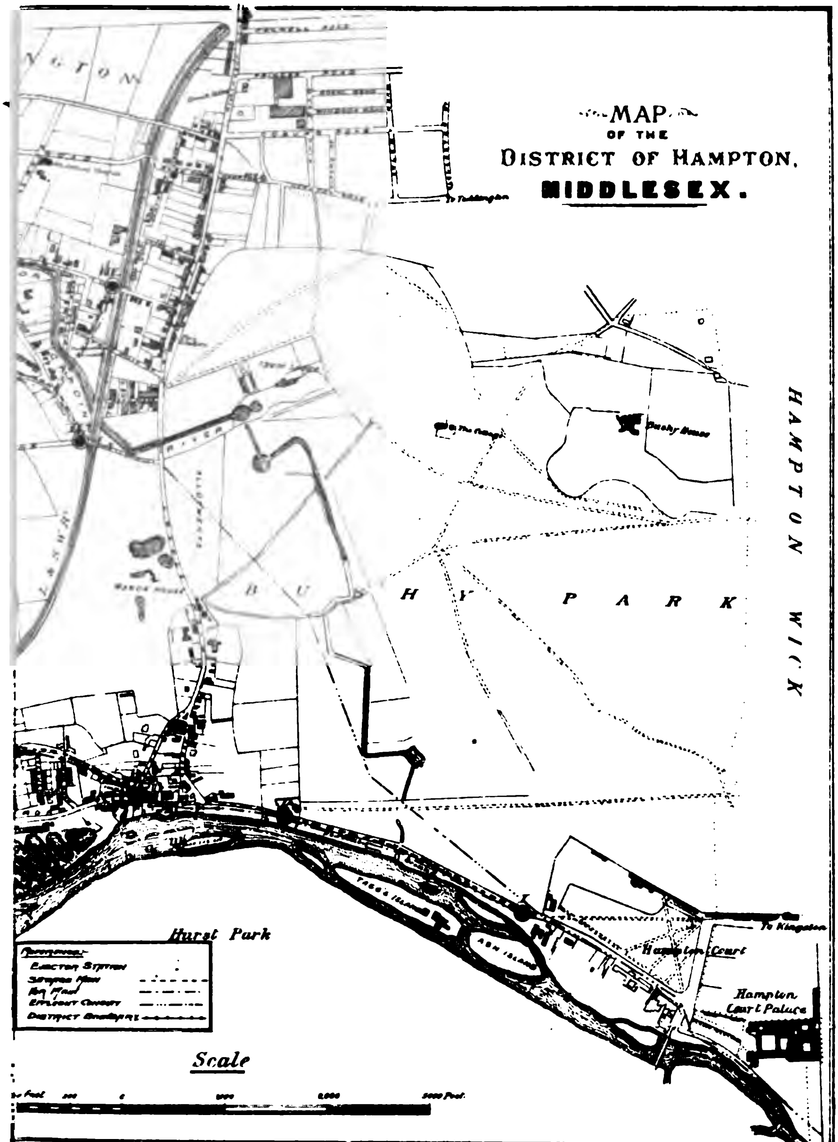
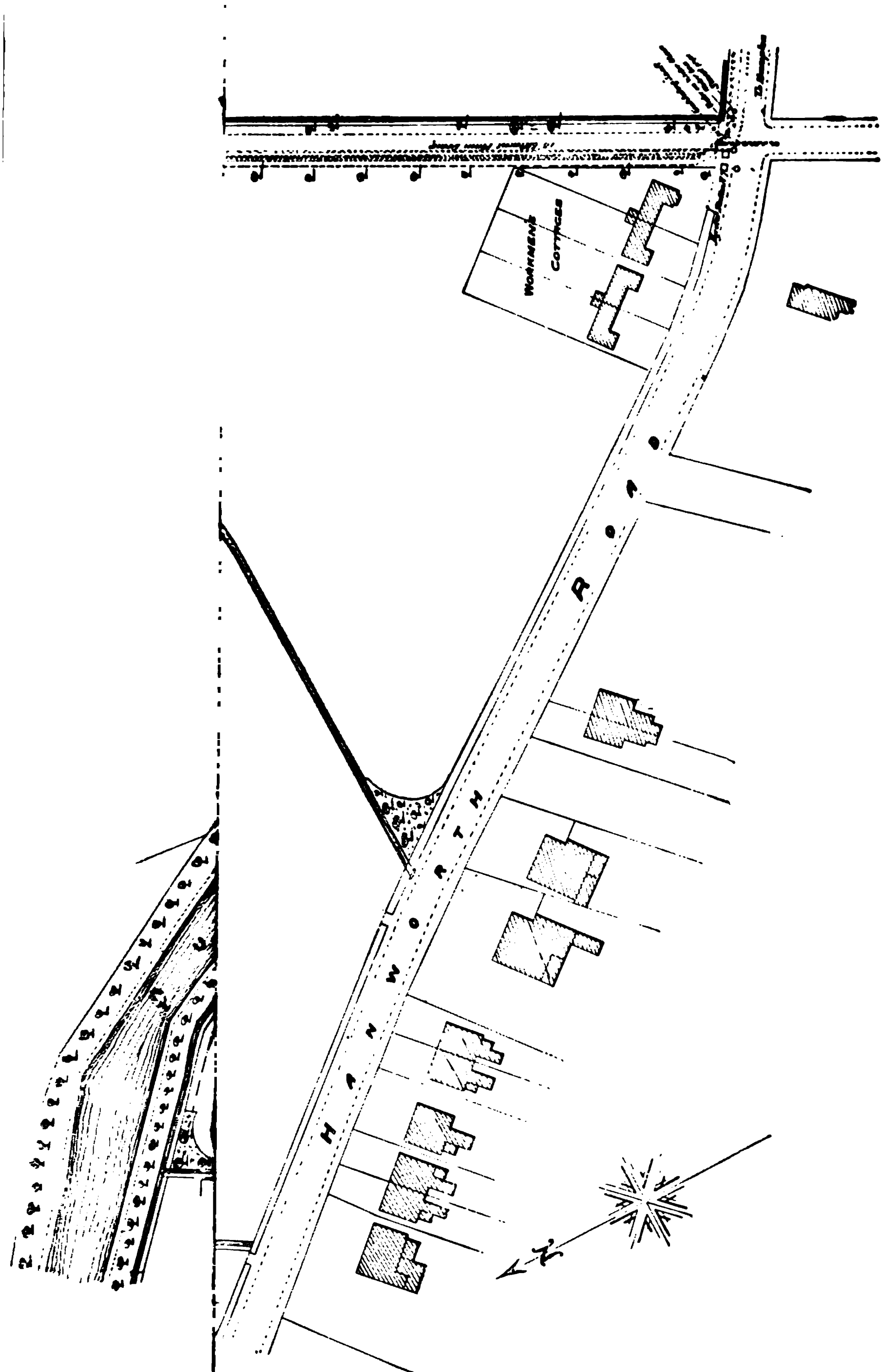


PHOTO-LITHO SPRAGUE & C L LONDON



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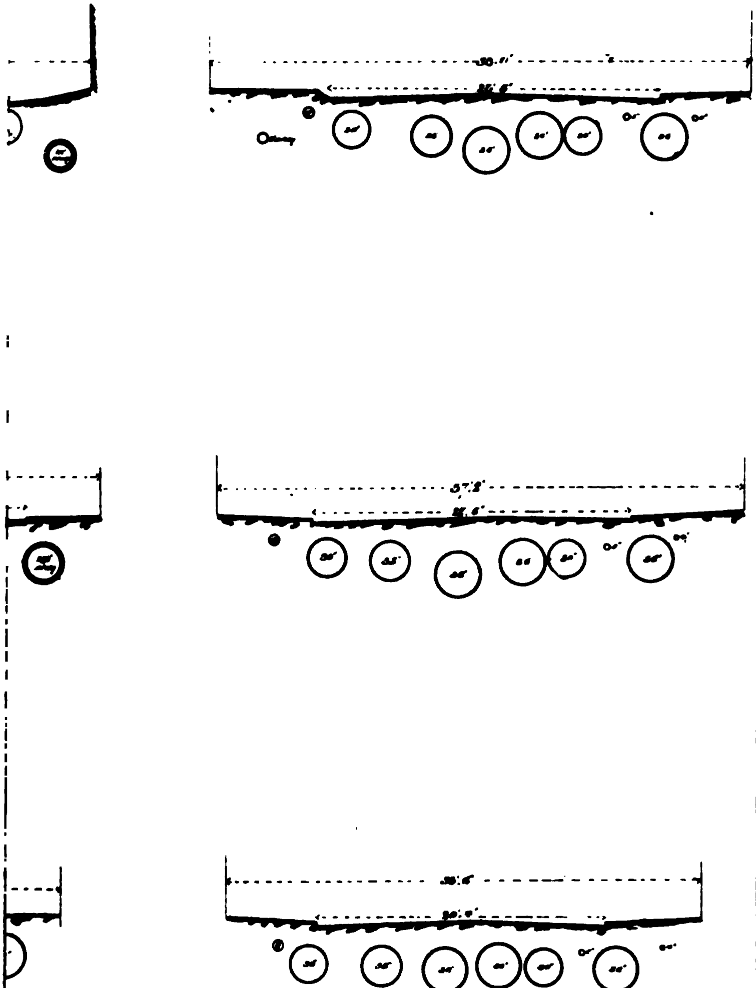


MPTON SEWERAGE.

SECTIONS SHEWING POSITIONS

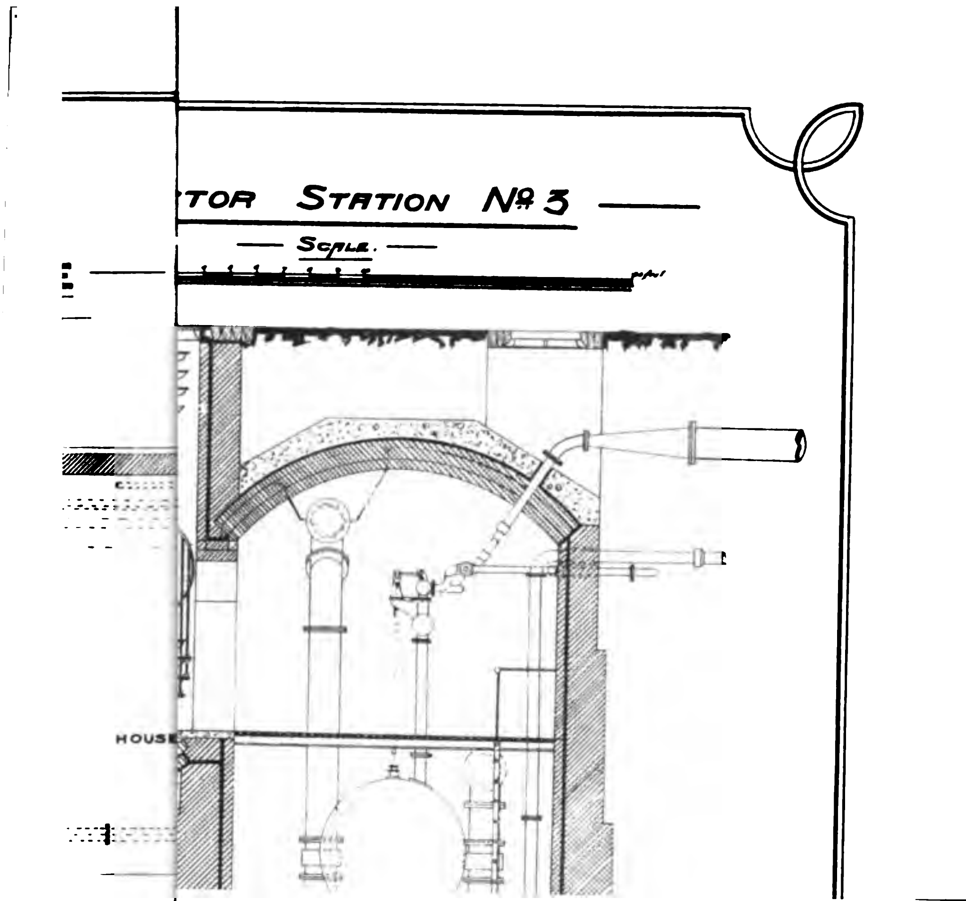
OF

GAS AND WATER MAINS

IN

HIGH STREET & THAMES STREET

PHOTO-LITHO SPRAGUE & Co LONDON.



The *modus operandi* is as follows:—A coarse bed is filled

The chimney shaft is octagonal in shape, 90 feet high above ground, and lined with fire-brick to a height of 25 feet.

The whole of the buildings are built with red bricks, obtained from Messrs. Tucker and Sons of Loughborough.

The same firm's pressed bricks were also used for the brick ejector stations and for manholes, and the Author has very much pleasure in testifying to the excellent quality of these bricks for both purposes.

Bacteria Beds.

The sewage is delivered by the ejectors into a screening chamber, where it passes through a ½-inch mesh screen, and from thence direct to the bacteria beds without sedimentation.

These beds are fifteen in number, built in terraces of five each. The whole of the beds are built of concrete, which is rendered in cement on all exposed surfaces, but left rough below. The floor of each bed has a fall of 6 inches from end to end, and is drained by semicircular 5-inch drains formed in the concrete at 2 feet 6 inch centres and rebated to receive a 6-inch perforated tile covering. These drains communicate with the main receiving drain, connected with which are three 6-inch screw-down sluice valves to draw off the effluent.

The beds are 4 feet 4 inches deep. The coarse beds are each 34 feet 6 inches wide by 50 feet long, filled to within 4 inches of the top with coarse clinkers rejected by a ¾-inch sieve; the medium beds are each 35 feet 6 inches wide by 54 feet long, filled with clinker passed through a ¾-inch sieve and rejected by a ¼-inch sieve; the third, or fine beds, are each 35 feet 6 inches wide by 58 feet long, filled with the residue of the material from the second beds, and consisting largely of fine powdered clinkers and ashes.

The liquid capacity of each of the coarse beds when newly constructed was 20,000 gallons or 46 per cent. of the total, and this capacity has not diminished, although the beds have been working since December 8, 1898, when the first connection was made with the sewers. Something like 4200 persons are now connected to the sewers and the quantity of sewage treated at the works is about 98,000 gallons per day; this includes about 4000 gallons of flushing water, so that the dry weather flow is about 22½ gallons per head per day.

The *modus operandi* is as follows:—A coarse bed is filled

within about 4 or 6 inches of the surface of the bed material, allowed to stand full about two hours and then emptied slowly (taking about one hour) through the three valves provided, and this process is repeated with the medium and fine beds. In each case, when a bed is emptied the valves are left open until it is required to be filled again, to assist aeration.

Each bed is allowed one week's rest in five, so that one set of three beds is always resting; this means that with the present flow three sets of beds are filled once each, and one set twice.

Various methods of charging the coarse beds have been tried, such as shallow troughs running the length of the beds; half pipes, with branches right and left, and latterly on three beds, shallow bays, about 8 or 10 feet wide, running across the entire width of beds and sunk about 6 inches below the level of the top have been used with good effect. Each of these three beds is cleaned by skimming the surface and lightly turning it over after the week's rest.

The other two beds were constructed rather differently, the spaces for drainage at the bottom being filled with large clinker, there was also a layer of 9 inches or so of larger clinker on the top; three rows of 4-inch land drain-pipes were carried through the body of the bed about 1 foot from the bottom and returned at the ends to above the surface to assist aeration.

It has been necessary to clean the surface of these two beds only once since they were constructed, although they have taken more than their share of sewage.

The method of distributing the sewage on four of the medium grained beds, is by three longitudinal rows of 12-inch half channel pipes on each bed, having 6-inch branches running right and left 2½ feet apart; on the fifth bed the sewage is allowed to flow over the surface of the bed without any special means of distribution. The half-channels not only distribute the sewage but collect a kind of spongy, livery matter coming from the coarse beds, which, if allowed to get into the body of the material, might have a tendency to choke it. The surface of these beds requires no attention and has not been molested since they were constructed.

The effluent from the medium beds passes on to the fine beds without any special distributing apparatus, the surface requiring no attention except weeding occasionally.

The land is underdrained by drains communicating with the main effluent drain emptying into the Thames below Hampton Court Palace.

According to a Report prepared by Mr. Charles E. Cassal, in October 1899, the Hampton sewage is strong domestic sewage absorbing in four hours 129·4 parts per million of oxygen from permanganate, and containing 79·32 parts of saline ammonia and 15·2 parts of organic ammonia per million.

By referring to the Report of Mr. Cassal, appended hereto, it will be found that the percentage of purification obtained as reckoned under the heads of oxygen absorbed and ammonia reduced, is as follows :—

	Oxygen absorbed.	Ammonia reduced.
Percentage of purification	96·9	97·5

Two of the beds were within the last few weeks tested by careful measurement for loss of capacity—this was inappreciable, although the beds have been working close upon two years.

In the Author's opinion no better material than furnace refuse, such as that in use at Hampton, could be obtained for bacteria beds. By its use the largest possible liquid capacity is obtained in the beds, which is a great consideration in the cost of construction, nor does this material deteriorate by disintegration. Whether the material has anything to do with the retention by the beds of their original liquid capacity, he is unable to say, and it would therefore be interesting and instructive to have the experience of those who have tried other materials under similar conditions—that is to say, without the sewage having previously been subjected to sedimentation.

There is no doubt that by the adoption of the bacterial method of treatment the District Council has saved a large annual expenditure, which would otherwise have been incurred in the cost of chemicals, labour and sludge pressing. The fact, too, that the effluent is of such quality and nature that it can safely be used in the boilers, is another gain as regards annual expenditure.

So far as actual disposal of the sewage goes, one man does the work with a little assistance occasionally. Assuming that a chemical and precipitation process of treatment had been adopted at Hampton, accompanied by sludge pressing, the total cost per annum would have been about as follows :—

Annual flow of sewage on a population of 7500, at 25 gallons per head = 68½ million gallons.

	£	s.	d.
Cost of chemicals, at 40s. per million gallons	137	0	0
Cost of precipitation and sludge pressing, at 60s. per million gallons	205	10	0
	£342	10	0
The actual cost of the bacterial method is the labour of one man assisted occasionally, say per annum ..	104	0	0
Saving per annum by bacterial process ..	£238	10	0

The cost per head of the population works out as follows:—

Bacterial method	3·3 pence.
Chemical "	10·9 "

Although only one analysis has been taken by the Council the effluent from the bacteria beds has always satisfied the Thames Conservancy, who take their samples both from the effluent of the third contact bed and also from that passing through the land, and therefore, so far as the Author's experience goes, there is no necessity whatever to pass the effluent from the beds over land.

Since the opening of the works some 33,000,000 gallons of sewage have passed through the beds representing approximately 528 tons of pressed sludge, calculated at the rate of 16 tons per million gallons.

The actual amount of semi-dried sludge and black spongy material removed from the surfaces of the beds has not exceeded 10 tons, and the bed material, as ascertained by opening out a section to the under drains, is, with the exception of about 9 inches of the surface, apparently cleaner than when put in; the under drains were also perfectly clean.

The superficial area of the coarse bed material is 958 yards; medium 1065, and fine 1143 yards, or a total of 3163 yards.

Construction of the Works.

The contract for the machinery, cast-iron ejector chambers, air and sewage mains, was let to Messrs. Hughes and Lancaster, and carried out in a very satisfactory manner.

The whole of the sewers, effluent water drain, brick ejector chambers, buildings, bacteria beds, &c., were constructed by the Council departmentally under the direction of the Author, who was ably assisted by Messrs. J. R. Blanford of Reading as

manager and clerk of works, J. R. Wade second clerk of works, and S. H. Chambers and F. Barnes of the Surveyor's office as assistants. A timekeeper and store-keeper were also appointed.

The Author had hoped to give a very full account of his experience of a works department, but lack of time and the knowledge that the paper has already exceeded the length he intended compels him to be as brief as possible.

The chief reason which induced the Council, on the Author's recommendation, to construct the sewers departmentally, was on account of obstructions in several streets caused by the existence of the large trunk mains of the various water companies. There are altogether some 14 miles of these mains in the district, varying in diameter from 30 to 42 inches, laid at varying depths and in anything but regular or straight lines. In some streets there are as many as six of these huge pipes, running side by side, as well as small gas and water pipes, etc. Some of these are shown in section on Drawing No. 2.

These obstructions were such that in some cases a sewer had to be constructed on each side of the street in the footway and close up to buildings; where this could not be done, back drainage had to be resorted to, and the sewer carried through private lands.

The Council, seeing the great expense and unfairness to owners of property abutting upon such streets having to make and pay for connections to the sewers under these conditions, resolved to carry up all house connections to the boundaries of the several premises and to defray the cost out of the loan. This work was done at the same time as the sewers were laid, at a cost of 3000*l.*

Whenever sewers ran close alongside or under the water companies' mains, concrete piers, 3 feet long and the full width of the trench, had to be constructed behind every socket exposed, the mains being slung in the meantime by chains to heavy balk timber; in addition to this large quantities of timber had to be left in the trenches, especially when the sewers ran close to buildings or water mains.

The work under such conditions naturally proceeded slowly as the greatest care had to be exercised, but the Author is pleased to record that throughout the work not a pipe or joint was broken nor the slightest damage done to any building.

The sewers were laid on a bed of concrete as before described,

and were then tested by hydraulic pressure from manhole to manhole with a head of from 6 to 8 feet. The test being satisfactory, the pipes were then haunched up with concrete, about two-thirds of the way up the pipe; the trenches were filled in as soon as the concrete had set.

The manholes were built in 14-inch brickwork, the work being executed "trough" fashion, that is, the bricks were all laid as stretchers, the two outside courses being laid first so as to break joint horizontally with the middle course, the space or trough left between was bedded and lined with cement mortar, and the bricks well rubbed in; by this means the length of the horizontal or bed joint was increased by some 3 inches. The mortar was composed of 1 of Portland cement to 1 of sand, and the work was perfectly watertight without rendering afterwards.

The subsoil drains, constructed of agricultural butt-jointed pipes, kept the trenches clear of water, although the length sometimes was very considerable, and running sand had to be contended with all over the district. In no case did they block up. Where outlets could not be obtained below the invert of these drains a well was constructed and the water allowed to rise and overflow into the nearest surface water drain, the effluent water drain, or other suitable outlet; in this way the ground water was lowered to a minimum of 8 feet below the surface all over the district.

Buildings.

It was at first intended to put these up by contract. Tenders were received, the lowest being 2400*l.*, which was afterwards withdrawn, the contractor stating that he had omitted something and could not do the work for the money.

The Council carried out the work departmentally for 2296*l.*, The chimney shaft is 90 feet high above ground level.

Bacteria Beds.

The ballast for the concrete used in the construction of the beds was obtained from the sewer trenches, ejector chambers, excavation and on the site. The material forming the beds was obtained from the three water companies' works in the district, and was delivered on the site at 1*s.* per cube yard.

The management of the works since completion has been under Mr. T. Hughes, and it is in a great measure due to

his intelligent and capable management of the bacteria beds in particular that they have worked so satisfactorily.

The first sod was cut on March 7, 1896, by Frederick Fisher, Esq., the then Chairman of the Council, and sewage was first delivered to the disposal works on December 8, 1898, or in three months less time than the Council requested the Author to have the works in readiness to receive sewage.

The Author is pleased to state that the sewers, although in many places under water, are practically tight, and that therefore a minimum quantity of sewage has to be lifted, and dealt with by the beds. Rain water, whether from roads, roofs, or yards, is practically excluded. All house drains are tested by hydraulic pressure before being covered up, and afterwards by the smoke test, so that everything possible has been and is being done to prevent leakage from the sewers and drains or infiltration of ground water. In the opinion of the Author the permanent lowering of the ground water has also been of great benefit to the district.

The cost of the whole scheme was as follows:—

	£	s.	d.
Sewers and effluent water drain, 16¾ miles, including manholes, flush tanks, &c.	25,416	5	1
Cast-iron sewage and air mains	6,058	6	6
Communication pipes for house drains carried up to boundaries	3,000	0	0
Eight ejector stations and ventilating arrangements	4,184	6	6
Buildings and outfall works	2,296	3	3
Ejectors in duplicate for eight stations, steam engine, air compressors, condensers, boilers, air receiver, etc.	7,302	16	1
Fifteen bacteria beds in concrete, including all materials for beds, and effluent aerator lift ..	2,970	2	7
Other outfall works, including 20 acres of land at 175*l.* per acre, drainage, trenching, fences, roads, and extension of 9-inch intake pipe to Crown filters, a distance of 800 yards	6,359	0	0
Engineering, legal, supervision, compensation and management expenses	4,328	0	0
	£61,915	0	0

The total original estimated cost of the works was 56,585*l.*; the actual cost of the work over the estimated cost was therefore 5330*l.*, a great proportion of which was incurred on account of the obstruction caused by water mains.

APPENDIX.

Report upon an Inspection of the Hampton Sewage Works, and upon the Analysis of Samples of Sewage and Effluent Water taken at Hampton on October 5, 1899, by Charles E. Cassal, F.I.C., Public Analyst for Kensington, St. George's, Hanover Square, Battersea, the Administrative Counties of Kesteven and Holland, Lincolnshire, etc., etc.

On October 5, 1899, accompanied by Mr. John Kemp, C.E., I visited the sewage works at Hampton, and made a careful inspection of the works, and of the system of sewage disposal in operation there. The process having been carried out in my presence, I took samples of the sewage and effluent waters at suitable points, and I certify that the result of my analyses of these samples were as stated in the appended analytical report. The system employed, which is fully described elsewhere, consists essentially in the purification of sewage by a process of filtration and exposure to bacterial action under controlled and effective conditions. From a consideration of the analytical data obtained and of the facts observed during my inspection, I am of opinion that the conditions referred to are fulfilled at the Hampton works, and that, having due regard to the destination of the final effluent, the results attained are remarkably satisfactory, and must amply meet all the requirements which can reasonably be held to apply. The works are very well designed for the purpose in view. It is evident that they are carefully managed, and they do not cause a nuisance. There were no accumulations of sludge, the filter-beds were not clogged, and the channels and drains were clear and clean. These points are of considerable importance and interest in view of the fact that, as I am informed, the process has been working continuously for a period of ten months. The principal conclusions which may be drawn from the results of the analyses of the samples taken are as under stated:—

No. 1. Raw Sewage.—This was a sample of strong town sewage of very offensive character, and containing a very high amount of organic matter and a considerable quantity of matters in suspension. I was informed that it might be taken as a fair sample of the Hampton sewage. An idea as to the extent of the purification effected by the process may be obtained by making comparisons upon broad lines between this sample and the samples of effluent water under the circumstances of this case.

No. 2. Effluent after the Triple Treatment.—This was an effluent water of very good quality. The analytical data afford ample evidence

of the effective action of the process. For an effluent water, the figures, which are a measure of the amount of organic matter present, are remarkably low. The amount of organic ammonia yielded by this effluent water was only one thirty-fourth part of the amount yielded by the raw sewage (No. 1); and the amount of oxygen required for the oxidation of organic matter was, in the case of the effluent water, only about one thirty-third part of that required in the case of the sewage. The effluent water was free from suspended matter, was clear and bright, and entirely devoid of offensive odour.

No. 3. Effluent after passing through "aerator lift."—This sample was closely similar in character and composition to No. 2, and practically the same remarks as those made in respect to No. 2 apply to this sample also. The figures indicative of the amount of organic matter present are, however, slightly lower than those obtained with No. 2, and the sample may therefore be looked upon as a slightly better one. As in the case of No. 2, it was free from suspended matter, clear and bright, and entirely devoid of offensive odour.

No. 4. Effluent after passing through Land.—This sample is not so satisfactory as Nos. 2 and 3, in so far as the amount of organic matter present is concerned. The figures for organic ammonia and for oxygen required are nearly double those found in the cases of Nos. 2 and 3, but are still low figures for an effluent water of the kind. So far as it is possible to judge without a far more extensive investigation than has been possible, it would appear that the passing of effluent through land is of no value for the purpose of improving the effluent, and that it might be dispensed with. Such evidence as is now available goes to show that, at present, the effluent becomes deteriorated by being passed through land.

No. 5. Effluent as discharged into River.—I am informed that the effluent from the land is diluted on its way to the river by the entrance of unpolluted water at two or three points. The results show that the sample resembles No. 4, but is, in a very marked degree, better than the latter. By the dilution of such a water as No. 4 in the manner mentioned, such a water as that represented by No. 5 would be produced. I see no objection to the discharge of this effluent into the river at the outfall point. The banks and the bed of the river at the outfall point showed no signs of sewage pollution. Inasmuch as the results show that Nos. 2 and 3 are considerably better than Nos. 4 and 5, it is plain that the passing of effluent waters of this composition into the river—especially if still further improved by admixture with unpolluted water, as is the case with No. 5—would be still more satisfactory.

CHARLES E. CASSAL, F.I.C.

HAMPTON SEWAGE DISPOSAL.

Analytical Report upon Samples of Sewage and of Effluent Water taken at the Hampton Sewage Works on October 5, 1899.

Number	1	2	3	4	5	—
Appearance in porcelain vessel 1 in. in depth.	opaque and thick, strong sewage colour.	clear and bright, colourless.	clear and bright, colourless.	slightly cloudy, slight yellowish tint.	clear, very faint yellowish tint.	
Appearance in 1 ft. tube.	opaque and thick, strong sewage colour.	clear and bright, slight greenish-yellow tint.	clear and bright, slight greenish-yellow tint.	clowdy brownish-yellow colour.	fairly clear, slight yellowish tint.	
Odour	very offensive ..	none	none	none	none	
Reaction	faintly alkaline	neutral	neutral	neutral	neutral	
Total solid matters ..	278·4	106·4	119·8	99·6	72·8	Parts per 100,000.
Chlorine as chlorides	89·0	18·5	20·0	17.5	10·0	" "
Nitrogen as nitrates	0·0	2·52	2·24	2·52	2·52	" "
Oxygen absorbed from permanganate, 80° C., 4 hours	129·4	4·0	3·87	7·18	5·43	Parts per 1,000,000.
Saline ammonia ..	79·32	0·968	1·02	8·82	3·45	" "
Organic ammonia ..	15·2	0·448	0·40	0·768	0·672	" "
Appearance of solids on ignition.	intense blackening (inflammable residue).	marked blackening.	marked blackening.	marked blackening.	marked blackening.	
Nitrates	absent	marked traces	marked traces	very marked traces	marked tracts	

Description of Samples.

No. 1. Raw sewage.
No. 2. Effluent after the triple treatment.
No. 3. Effluent after passing through "aerator lift."
No. 4. Effluent after passage through land.
No. 5. Effluent as discharged into river.

Remarks.

Suspended matters.—The raw sewage (No. 1) contained a large quantity of suspended matter. The effluents Nos. 2, 3 and 5 contained no appreciable amounts of suspended matters, while the effluent after passage through land (No. 4) contained 4·8 parts per 100,000 of suspended matter.

Charles E. Cassal, F.I.C

TABLE A.—Hampton Sewerage, on the Shone Hydro-Pneumatic System.

Number of the Ejector Stations.	No. 1.	No. 1A.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	
Note.—The sewage is ejected to the Outfall to the level of 68·25 above O.D.	At Cavalry Barracks ejects to No. 2 station.	At Hampton Court Road ejects to No. 2 station.	At Thames Street ejects to No. 3 station.	Cemetery Road, New Street ejects to outfall tanks.	Broad Lane and Uxbridge Road ejects to outfall tanks.	Windmill Road ejects to outfall tanks.	Hanworth, Long Lane ejects to outfall tanks.	Hanworth Road ejects to outfall tanks.	Totals.
Ground level at ejector station above Ordnance datum	26·15	37·47	34·53	56·73	53·73	53·10	57·40	59·41	..
Estimated future population of district	900	100	4000	3000	2000	4000	3000	3000	20,000
Sewage and rainfall, in gallons per minute	45	5	200	150	100	200	150	150	1000
Ditto, additional from other districts ..	..	..	50	250	..	..	..	..	300
Ditto total in gallons per minute.. ..	45	5	250	400	100	200	150	150	1300
Total dead lift of sewage, in feet.. ..	29·61	19·30	35·82	32·72	32·99	34·50	30·10	28·18	..
Total pipe friction	17·10	8·47	9·71	13·10	19·64	21·88	20·90	2·79	..
Total dynamic head	46·71	27·77	45·53	45·82	52·63	56·38	51·00	30·97	..
Equivalent air pressure, 1 lb. per square inch	21·0	13·0	20·0	20·0	23·0	25·0	23·0	14·0	..
Free air required per minute, cubic feet	19·5	2·0	104·0	166·5	45·5	95·5	68·0	52·0	533
Material of which the ejector stations have been built	cast-iron tubbing	cast-iron tubbing	cast-iron tubbing	brickwork	brickwork	brickwork	brickwork	brickwork	

DISCUSSION.

The President: I will call upon one of our Vice-Presidents, Mr. Weaver, to propose a vote of thanks to Mr. Kemp. I will only say we shall all agree that it is a very excellent paper, and that Mr. Kemp has done most important work. This scheme, as it appears to be, on the Shone system reminds me of the great prejudice that system had to meet some fifteen years ago; that prejudice has now been broken down, and we know how many successful schemes have since been carried out on that system.

Mr. W. Weaver: I have very much pleasure in proposing a vote of thanks to Mr. Kemp for the very able paper he has placed before the Association to-day. I do not propose to inflict upon the meeting any lengthy remarks, but will merely content myself with discharging the duty of proposing a vote of thanks. This district is very well known to me, as my own district lies in the west of London, and it has always appeared to me a well kept and salubrious neighbourhood. The roads you travel over are in good order, and you never detect any smells as you drive about the district. Whether this is due to the absence of surface sewer ventilators I do not know. There is no reference to surface ventilators in the paper; but Mr. Kemp refers to ventilating the sewers through the ejector chambers. If there are no surface ventilators on the sewers, I should like to ask whether he finds these ejector ventilators at distant intervals sufficient to ventilate the sewers, or whether it could be improved by inserting a ventilating pipe at the shaft at the building.

Mr. A. D. Greatorex: As my name has been mentioned by Mr. Kemp, I have extreme pleasure in seconding the vote of thanks for the most interesting and valuable paper he has read this morning; I must also congratulate him upon carrying out the whole of this scheme in such an excellent manner—both the way in which I understand the work has been done, and the way in which he has kept so well within his estimates. There are no doubt exceptional circumstances in some portions of the work, as we have seen from the drawings, which account for the increased cost in laying some of the sewers. I must also congratulate Mr. Kemp upon his courage in having thrown over the original scheme and

adopted the bacteria treatment for the sewage. I think it is well known to the whole of the Members of the Association that I have for some time been dealing with a large quantity of sewage on this system, and as my experiments have been running for twelve months, I am now in a position to give analytical results which bear out Mr. Kemp's statement that sewage can be dealt with sufficiently by this system without the aid of land. One portion of the sewage of West Bromwich—the high level—is dealt with through a coarse bed, and then the effluent is passed on to the land. This bed has dealt with, in twelve months, some twelve million gallons of sewage, and the average of eighteen analyses is as follows:—Oxygen absorbed in four hours ·369; nitrogen, nitrates and nitrites 1·260; albuminoid ammonia ·042. I think you will all agree with me that is an extremely good result. The low level has a coarse and also a fine bed. The Local Government Board, in sanctioning the loan, insisted that the effluent should be put on land, and to do that we had to pump it. Those beds have dealt with about forty million gallons of sewage in twelve months, and the result of a similar number of analyses is as follows:—Oxygen absorbed in four hours ·457; nitrogen, nitrites and nitrates ·447; albuminoid ammonia ·06. These results are very satisfactory. They are, in fact, much in excess of any standard laid down at the present time. You will notice the result from the high level is much better than the low level; but of course it all depends upon the quality of the land on which you put the effluent. Though the putting of the effluent on land is insisted upon by the Local Government Board, we find very little benefit from doing so. There is a slight benefit, but that is due to the land being of good quality. I am absolutely convinced that there is no necessity to put the effluent from fine beds on to the land where the sewage can be dealt with on this system. I am very sorry to find that only one analysis of the effluent has been made here. I think, considering that these beds have been dealing with the sewage nearly two years, it is a mistake on the part of the Council of Hampton to have had only one analysis taken; I think they would be well advised to have samples analysed once a quarter, if not once a month. I am aware the chief objection raised by councils is the question of expense. Well, I think it is false economy because if it cost 100 guineas or 200 guineas it would be money well spent if only

to show the ratepayers of the town that the Council had adopted the right system. I would strongly urge upon the Council to have these analyses made. During my experiments, I have had daily records taken of the temperature of the sewage, and the beds and the effluent and the varying conditions all through the whole of twelve months, and I find that the temperature never affected the beds during the hardest frost in winter, but that they always dealt with the sewage in a satisfactory manner. I must apologise to the meeting for mentioning my own case, but I do so simply with the object of strengthening the hands of those councils who have still to deal with this very difficult problem.

Mr. J. S. Pickering: I notice Mr. Kemp states that the liquid capacity of the bacteria beds has not diminished, but I should like to know how that has been ascertained, as I cannot understand how it can possibly be, especially as there are no sediment tanks. I should like to ask whether the effluent from the beds has been gauged by a notch or weir, or something of that kind, because in that case I should hesitate to accept the results. I think the only way in which to accurately gauge the flow from the tanks is to measure it by a meter. It certainly seems incredible that after two years' work there should be no diminution whatever in the capacity of the beds. In a paper read at our Annual Meeting it was stated on the evidence of an eminent chemist that it had been proved at Hampton that the effluent after leaving the land was worse than before it went on to it. I rather doubted at the time that that was so, and I wanted to know whether there was more than one analysis to prove this. We are told now that only one analysis was made. That is rather a bold statement to make as to what land will do on the strength of a single analysis. I should like to ask, as the rising main varies from 7 to 16 inches in diameter, what the velocity of the sewage is calculated to be in running through the 16-inch main, because it strikes me as being a large main for so small a quantity of sewage. It is stated that the whole of the roof water goes into separate sewers; does that include the back roof and yard water? It is found in practice that builders, when laying house drains, often connect the water closet with the surface-water drain if there is a double system of drainage, and that results in a very serious nuisance.

Mr. Shone: I am here simply as an onlooker and a listener, but I may be permitted to make some observations in reply to

Mr. Pickering. Mr. Pickering could not understand why there was a difference between the mains of these different ejector stations and the outfall, and he asked very naturally why a 16-inch main should be employed to drive the sewage of a comparatively small population to the outfall. But the pipes driving the sewage to the outfall from the various ejectors at the present time are not only suitable for present requirements but they will be suitable also for future—at any rate they will suffice until the population numbers 20,000. It is the peculiarity of these ejectors that they go off intermittently, and possibly several of them go off simultaneously, and so adding to the velocity with which the sewage is discharged through the mains to the outfall. I was very glad to hear Mr. Greatorex recommend the Hampton Council to have frequent analyses taken of the effluent. The Chairman of the Council of Hampton, Mr. Saunders, has listened to what Mr. Greatorex has said, and probably will influence his confrères sufficiently to induce them to take measures to have these analyses made. We were indeed extremely fortunate in getting even one analysis made of the effluent from the works. Mr. Greatorex said very truly the objection is the expense attending the taking of such analyses, but after all it is a very paltry one. At the same time, gentlemen who become members of the Local Councils must be forgiven for not seeing, as we do, the importance and value of these analyses. I am sure the Chairman of the Council will take notice of this request. It would indeed be of great interest if the Council could take the advice which has been given; and if they cannot take daily records, at least take quarterly records. It would not cost much, and would be of great value. I think you will agree with me when you have seen these works that they are what they are represented to be in Mr. Kemp's paper. Hampton is a very large, straggling district, and it speaks volumes for the public spiritedness of the Members of this Council that they considered themselves warranted in going to the great expense of carrying out the scheme described by Mr. Kemp. You will notice the present population is small and the expense comparatively very large. Of course at Hampton there are very large ratepayers in the district in the shape of water companies, and in that way the Council has been able to carry out these works without unduly hurting the ratepayers generally. I hope you will go round the district

to inspect the works, and if so you will be able to get a very good idea of the difficulties of draining it. And if you go to the outfall works you will see an effluent the like of which I have never seen. My friend Mr. Fowler was present at the opening of these works, and he said he had never seen anything like so good an effluent from such strong undiluted sewage, and Mr. Santo Crimp, who was here the other day, said practically the same thing. I am perfectly astounded at the result which has been obtained. It has been remarked that it is a strange thing that there is no sludge from these tanks. Well, that is a thing you can ascertain for yourselves if you will go and inspect the bacteria beds. Those who are sceptical as to the absence of sludge have probably dealt with the sewage on the *combined system*, in which a quantity of detritus from the roads comes down to the outfall works to be dealt with. In this scheme, so far as is possible, all rainfall has been eliminated from the sewers, and I believe it is wholly in consequence of this separate system that the treatment of the sewage here is so successful. I am inclined to think that the ejector delivery or outfall mains here become, so to speak, septic tanks, and thus assist in the ultimate treatment at the works. The sewage is driven automatically, but intermittently by compressed air into these large 16-inch mains, which become, as it were, septic tanks, and, as the sewage probably absorbs some of the compressed air, it doubtless arrives at the outfall works more fully charged with oxygen than it otherwise would be. Possibly this has some influence on the sewage, and some effect in producing this excellent effluent which you will see.

Mr. A. M. Fowler: I have seen a great many patents, have practised a good many of those patents, but I have yet to be positively satisfied that there is anything better than the system now universally recommended by the Local Government Board. My friend Mr. Shone was quite right in saying that I had never seen an effluent better than that I saw here on that occasion. The question in my mind then was, will it be maintained? Perhaps it will; but we notice that there has been some slight alteration in the beds, and with bacteria beds formed in this way we are prompted in our minds to think that the capacity of these beds will, in the course of time, be reduced. Take, for instance, a water-works filter: you finish it off at the top with fine sand. We know that the flocculent matter never gets

beyond that fine sand, you wash it off and it lasts for years, but when you come to have an open filter constructed it will deteriorate not only in material but in capacity of filling and discharging. With a water-works filter, the work is either regulated by a valve to give the minimum quantity of discharge through and from the bed, or the outlet is syphoned up to within a few inches of the top to prevent any great downward draught through the filter bed. When you come to consider these things in a practical form it naturally occurs to you that the capacity of that open filtering medium must be less in the course of time. The question in my mind is, will it be so? You may say you can get rid of all the mud, but there is also a large quantity of debris, road washing, and all that sort of thing, and no amount of bacteria will ever absorb that. Do you mean to tell me that there will be one town in a hundred which will have no debris in the sewers? And where does it go to if they do not deal with it as mud? Of course, if you have a settling tank and take the mud out before it goes on to the beds, then you will reduce it to a minimum. But, to say that all the mud can be taken out by means of bacteria beds is to claim something that I do not think can be done, and I have the courage of my opinions to say so. You may adopt twenty different methods of clarifying sewage which will make it perfectly bright, which will give you an effluent as bright and brilliant as water from a water-works filter, if you will only go to the expense of doing it. It is simply a question of cost. These bacteria beds are costly; their working will have to be carefully watched; they are as delicate as the mainspring of a watch. Leeds has been working and experimenting for three or four years and is not satisfied. I remember that in 1866 the shares of the A.B.C. process of sewage purification went up in price because Leeds adopted the system, but they could not work it because of the expense, and they are simply using lime to-day. No doubt the scheme is a good one, but I must have the results verified under varying circumstances and conditions before I can accept it. Of the Shone Ejectors I can speak in the highest terms. I have many constructed in different parts of England, and they work satisfactorily.

Mr. C. Chambers Smith: I agree to some extent with what Mr. Fowler says as to the capacity of bacteria beds. The liquid

capacity of each of the coarse beds is stated to be 46 per cent. of the total, and it is claimed that this capacity has not diminished though the beds have been working since December 1898. I really think there must be some discrepancy, and it would be advisable to verify the figures. In the case of my beds at Sutton the liquid capacity has diminished from 40 per cent. to 25 per cent. That is exceptional to some extent, owing to the use of burnt ballast, which is not a good material; but it bears out this, that even if you exclude all road debris and all roof water you cannot prevent some mineral matter coming down the sewers and getting into the beds and reducing their capacity. In all sewage, it must be remembered, you get a certain quantity of mineral matter, which has a tendency to convert your coarse beds into fine beds. With regard to the efficiency of bacteria filters, I think there are very few Members who doubt this at the present time. There are one or two points raised, which I will take very briefly. First, with regard to analyses. I can quite understand a small Authority not wishing to go to the expense of analyses once a month. It has to be remembered that these effluents are examined and analysed every month by the Thames Conservancy, who are the people from whom the local authorities have everything to fear. Unfortunately, however, their analyses are not published, so that unless local authorities take samples for themselves and submit them to an independent analyst, they are partially groping in the dark, and it is therefore desirable that analyses should be made say not less than once a quarter. The depths of the beds here is 4 feet 4 inches, but they can be made as deep as 12 feet, and it has been proved that you get equally good results with a bed 12 feet deep. I admit that originally 4 feet 4 inches was considered the proper depth; but experience has proved you can work with a much deeper bed. I notice the size of the coarse grain and the fine grain beds are the same, but the liquid capacity of a coarse bed and a fine bed differs considerably, so that in designing the beds this should be fully taken into account. It occurs to me that a difficulty will eventually manifest itself in the absence of any form of screening at Hampton. A large quantity of paper comes down all sewers, and there appears to be no means of dealing with it here. Possibly it is broken up in passing through the ejectors, and there has been no need for screening on this account. With regard to the methods of

charging the beds, Mr. Kemp mentions three methods: shallow troughs running the whole length of the beds, half pipes with branches right and left, and shallow bays running across the beds. Perhaps Mr. Kemp will tell us which of those methods he prefers. It is also stated that it has been necessary to cleanse these beds only twice since they have been constructed. I have had one of these beds working for four years and we have not taken a shovel full of sludge from the surface since it was started. The percentage of purification obtained is good and the cost is satisfactory. It has been urged against the bacterial system that it is very expensive. At Sutton the total cost of working the farm when dealing with sewage by precipitation and sludge pressing was 15*l.* per million gallons; with the bacterial system the cost has been reduced to 3*l.* 19*s.* per million gallons. There is one other matter, that is the excellent material, viz. furnace clinkers, used for the coarse grain bed. One must congratulate Mr. Kemp on getting this material at 1*s.* per cube yard. I always recommend that clinker should be used in preference to burnt clay ballast. I must congratulate Mr. Kemp upon his admirable paper, and also upon the very excellent work which he has carried out in this district.

The PRESIDENT: I do not wish to add to the discussion, except to emphasize this question of capacity of bacteria beds. If everyone who is experimenting with this system would honestly and fairly make observations and experiments as to the diminution in capacity, and communicate the result, they would be doing a great work. It is the most important part of the question.

Mr. R. BROWN (*communicated*): There are one or two points which I should like further information upon beyond those given in Mr. Kemp's paper.

Reference is made to the ventilation of sewers, which appears to consist in providing what Mr. Kemp calls an inlet air shaft at the head of each sewer, the exhaust air from the ejectors creating a current through this inlet pipe by being discharged through a small pipe into and up an exhaust shaft connected with the contributory sewers. It would be of interest if the Author would tell us whether he has tested any of the so-called inlet pipes and the results of his tests, and—so that the

Members of the Association may calculate for themselves the theoretical effect due to the pressure of the exhaust air—if he would give the length and size of the sewers, the number and size of the inlets, and the size of the outlet pipe connected with any one particular ejector station.

It would add to our knowledge on the matter if Mr. Kemp would tell us to what extent the coarse beds get clogged, and also whether it is a fact either one of the coarse beds at Hampton has never required attention oftener than, say, once a week.

On the question of analysis, it is rather a pity that the result of only one is given, as there is a considerable difference between the analytical results of samples taken not only on different days, but at different times on the same day, and it would add to the value of the paper if, before it is inserted in the Proceedings, Mr. Kemp would persuade his Council to allow him to extend the tests over a period of one week, the samples being taken every hour, each sample being analysed, and at the end of every day a portion of each sample mixed together so as to get the average result for the day; and also at the end of the week, the average samples of each day mixed together and the results of the analysis noted.

Communicated Reply.

In reply to Mr. Weaver's question as to whether or not the ventilation of the sewers is satisfactory, having regard to the fact that the manhole covers are closed and that there is only one air inlet shaft at the head of each sewer, I wish to say that I have found the ventilation satisfactory and efficient, and I account for this by the frequent changes of air in the sewer caused by the discharges into the upcast shaft of the exhaust air from the ejectors. I have seen the effect of this exhaust 500 yards away from the ejector station, leaves and small pieces of paper being drawn into the sewer when placed close to the opening of the manhole. In reply to Mr. Pickering, the liquid capacity of the coarse bacteria beds was ascertained when the beds were newly constructed by filling them with sewage and then drawing it off into one of the empty medium tanks before the clinkers were put in. The quantity was then carefully measured, length, breath and depth, and I have no doubt whatever as to the accuracy of the measurement. None of the beds were measured

again until about a fortnight ago, when two coarse beds were measured. The quantity in both cases was ascertained by shutting off all ejectors discharging to the works with the exception of one of 500 gallons capacity. The number of discharges was then carefully taken, and both beds were found to have maintained their original capacity. I have ascertained that the ejectors are carefully made to discharge the quantity stated—viz. 500 gallons. In support of the accuracy of the measurement, the manager frequently tests the capacity by the number of revolutions made by the compressing engines in filling one of the beds, and this number has practically been constant for the past twelve months. It is further supported by the fact that at the time of the second test the day's flow was contained in five beds, being then equal to 22½ gallons per head of the population. If there was any diminution in the liquid capacity of the beds, say 15 per cent. or 20 per cent., then, of course, the quantity per head would be reduced by the same percentage, and would be under 20 gallons per head. I should hesitate to assert this to be the case in a fully water-closeted town and with sewers in water-logged ground too. I think the great percentage of liquid capacity obtained is due to the honeycombed nature of the clinker used, for it must be remembered that clinker varies very much, according to the different kinds of coal or other material from which it is produced. The 16-inch rising main is designed to discharge the maximum flow from an ultimate population of 20,000—say, 1250 gallons per minute; the velocity would then be about 2 feet 6 inches per second. Until that state of efficiency is reached the main can easily be cleansed by blowing the air through; this is done occasionally, but as yet there has been practically no sediment. In all pumping schemes where a considerable increase of population has to be provided for, the rising main must naturally be of sufficient size for the maximum ultimate quantity without causing undue friction in the main. The main is graduated from 7 inches diameter to 16 inches at the outlet. The length of 16-inch main is about 300 yards. I base my opinion that land is not necessary for final purification, not on a single analysis only, but from the additional fact that the effluent has satisfied the Thames Conservancy for practically two years, and has been termed by them "a good effluent." Replying to Mr. Fowler, I would point out that a minimum of debris and mineral matter

finds its way into the sewage, owing to the fact that all road, roof and yard water is rigidly excluded from the sewers—hence the retention by the beds of their liquid capacity. In reply to Mr. Chambers Smith, the bed material is 4 feet thick and the depth of the tank 4 feet 4 inches. Half-pipe channel distributors were originally tried on the coarse beds, but did not answer. The shallow wooden troughs answer well on two beds, where catch crops of tomatoes, etc., are allowed to grow unattended, and in the case of these there is no necessity for the men to tread over the beds to clean the surface, as the whole of the sludge disappears. The bacteria under these conditions appear to be more active and nearer to the surface. This is probably owing to the protection afforded by the crop. The paper on these beds gives no trouble, whereas on the other three beds it requires skimming off occasionally, to admit the liquid to the body of the bed. Some of this refuse is extracted by a ½-inch screen, but a considerable quantity finds its way on to the beds. The size of the gravitating sewers at each ejector station, with the exception of one sewer at No. 2 station and one at No. 3 station—which are respectively 9 inches and 12 inches—is 7 inches. These two sewers receive the sewage from other stations. The sizes of the rising mains are as follows: No. 1 station, 7 inches; No. 1A station, 4 inches; No. 2 station, 9 inches; No. 3 station, 10 inches; No. 4 station, 7 inches; No. 5 station, 8 inches; No. 6 station, 7 inches; and No. 7 station, 16 inches. Except at the outlets, there is no means of inspecting the subsoil drains. The reason they were laid at the depths stated was, in the first instance, to clear the trenches of water, and, in the second, to permanently lower the subsoil water to a reasonable distance from the surface.

Replying to Mr. Brown with respect to the system of ventilating sewers and its efficiency, the only practical test made by me was at ejector station No. 3. The length of the sewer communicating with the station is 530 yards; the manhole cover adjoining the inlet shaft at the sewer head was removed, and the effect of the exhaust air from the ejector was clearly demonstrated by the suction into the manhole and sewer of light road detritus, paper, etc., for a radius of 2 feet around the opening. A handkerchief held at the level of the road was considerably agitated by the strong current.

The experiment was merely for the purpose of ascertaining

whether or not the exhaust air did affect the air of the sewer for any considerable distance, the velocity was not measured; the size of the sewer was 9 inches; the exhaust from the ejector 3 inches; the exhaust shaft 12 inches diameter and 40 feet high. The inlets to three other sewers converging at the same point, and of about equal length, were open at the same time. The air was released at a pressure of 28 lb.

As to the question of the coarse beds clogging, I am pleased to inform Mr. Brown that there is no appreciable clogging of the beds, which retain their original liquid capacity.

With regard to his question as to whether it is a fact that any one of the coarse beds at Hampton has required attention oftener than once a week, I say that the beds themselves, apart from the sediment bays, which are cleared once a week exactly, are forked over about 9 inches deep once in six months, and that once in twelve months this depth is screened and replaced free of all small material.

After trying every conceivable plan, I have come to the conclusion that a bay about 8 or 10 feet in length, the full width of the bed, and sunk about 6 or 7 inches below the surface, is the best method of dealing with detritus and mineral matters. This bay is lined with fine ashes, from which the liquid is easily drained, leaving the residue in an easily portable condition, either to be dug into the ground or to be burnt in a destructor. There must be a residue, whether from a septic tank or otherwise, and I contend that such is much more easily dealt with on the top of the bed, where it can be seen and drained thoroughly, than in a tank where it is combined with the liquid.

On the question of analyses, I regret equally, and possibly more so, with Mr. Brown that my Council have not permitted more to be taken. I have tried to induce them, but unfortunately without effect.

This fact, however, remains, that the effluent direct from the beds has been running into the Thames continuously for now close upon three years, and has abundantly satisfied the Thames Conservancy, who have never made a single complaint, and the effluent has always been described by them as "good."

I am not aware whether the Association has power to expend money on analysing sewage effluents or of obtaining data as to

the working of bacteria beds, but I submit that it would be an excellent thing if the Association could take a lead in this matter—say, take charge of the Hampton Works for a short time. I believe the conditions obtaining as regards clogging are unique, if not also with regard to the effluent.

The Members then proceeded in brakes to the East Molesey Sewage Disposal Works, where they inspected the treatment of the sewage by precipitation and intermittent downward filtration, and the pressing of the sludge. Mr. W. G. Garland, Chairman of the Drainage Committee, conducted the Members over the works. After the inspection of the East Molesey Works the Members drove to the Lambeth Water Company's Extension Works, new storage reservoirs and intake works at West Molesey. Mr. T. F. Parkes, M. Inst. C.E., the engineer, showed the party over the works. Before leaving, the Members were entertained to luncheon by Messrs. T. Docwra and Sons. The next visit was to the Sewage Disposal Works of the Hampton-on-Thames District Council, where the bacterial treatment of sewage on the triple contact system was seen in operation. An interesting round of visits was brought to a conclusion with an inspection of the Southwark and Vauxhall Pumping Station at Hampton, with the new engine house and machinery recently erected.

DISTRICT MEETING AT WIMBLEDON.

March 16, 1901.

Held at the Council Offices, Wimbledon.

C. H. Lowe, M. Inst. C.E., President, *in the Chair.*

At the commencement of the proceedings the President proposed a vote of thanks to the Wimbledon District Council for having placed their Council Chamber at the disposal of the Association. This was carried unanimously. Councillor Major McSheedy, on behalf of the District Council, acknowledged the vote and tendered to the Members the Council's hearty greeting.

The President informed the meeting that since the death of Queen Victoria the Council of the Association had taken steps to express the feeling of the Members by forwarding a vote of condolence to the Royal Family in the loss that they and the nation had sustained by the sad event. They, at the same time, wished the King a happy and prosperous reign.*

The President referred to Mr. Sydney Stallard, who was now on his way to the front, and proposed that a telegram should be forwarded him conveying their hearty wishes and their hopes for a safe return. This was carried.

It was proposed by Mr. Hainsworth that the municipal bodies throughout the kingdom should be urged by the Council of the Association to delegate their surveyors to represent them at the forthcoming Congress at Glasgow. This was seconded by Mr. Harpur and carried.

Mr. C. H. Cooper, M.I.C.E., engineer and surveyor to the Wimbledon Urban District Council, said he felt an explanation was due from him on account of the absence of any paper descriptive of the works to be visited, but as he had already written a paper for an evening meeting of the Association he regretted he had not the time at his disposal in which to write a second paper at such short notice.

* See Appendix.

Three works were to be visited in Wimbledon to-day, namely:

The demolition of the old bridge that carried the principal street over the London and South Western and London Brighton and South Coast Railways, and the erection of the new bridge, sufficient of which had been erected to carry the traffic for the time being.

The old bridge had several points of interest: it had a total length of 162 feet in three spans, the longest being 72 feet; the width between the parapets was 30 feet, and the whole structure was carried by the two continuous girders which joined the parapets, and which were 7 feet deep with flanges 2 feet wide. These flanges were thickened where the bending moments were greatest.

Engines were frequently stopped beneath the bridge, so that the steam and fumes from these engines corroded the bottom flanges to such an extent that in one case nearly half the flanges had been eaten away; as luck would have it, these corrosions did not occur where the bending moments were greatest.

The new bridge has a maximum span of 52 feet and will have a width of 50 feet between the parapets, 30 feet of which will go to form the carriage-way and 10 feet on either side the paths.

The structure is carried on girders 2 feet deep with flanges 1 foot 6 inches wide. These girders are placed longitudinally, eight beneath the carriage-way and three beneath each path.

As thus constructed the new bridge will allow of widening, whereas the old bridge, carried as it was only on either side by girders which formed the parapets, could not be widened.

The next work to be visited is that of the depôt, Queen's Road, the buildings at which were in course of erection when the Association visited Wimbledon in April 1898. These buildings were completed during that year and have since been occupied. They contain:—

(*a*) Stabling for 39 horses, with 6 isolation boxes; when additional stabling is required buildings now used as cart sheds can be fitted up as stables.

(*b*) Fodder stores.

(*c*) Residences for horse-keeper and store-keeper.

(*d*) Office and stores.

(*e*) Workshops.

(*f*) Cart shed and steam-roller house.

The space between these buildings and the road, 30 feet in width, is laid out as a public garden and provided with seats.

A siding from the L. & S.W. and L.B. & S.C. Railways lines communicates with the depôt, and will be extended to serve an additional acre of land acquired for storage of materials, which will make in all 2¾ acres of open space available for materials.

Plans of the buildings and depôt appear in Vol. XXIV. of the Proceedings.

The Isolation Hospital will next be visited: it is situated on a site of 4·9 acres off Eap Road, being bounded on the west by the L. & S.W. and the District Railway, on the north by the Sewer Farm, on the east by the Cemetery, and on the south by Eap Road.

The eight buildings constituting the hospital were commenced in May 1899, and completed in September 1900, and consist of the following:—

1. Porter's lodge, with waiting room at entrance.
2. Receiving and discharging block, where in the one division patients received are bathed and attired in ward clothing, whereas in the other division they are bathed and attired in their own clothes on being discharged.
3. An administrative block, capable of accommodating nurses and servants to the number of twenty, with matron and doctor's rooms, stores, kitchen, wherein cooking for wards is done.
4. Laundry block, containing, in addition to the laundry, sheds for ambulances and cart for disinfected clothing, stable and disinfecting chamber.
5. A mortuary, removed as far as possible from other buildings, but close to the cemetery.
6. Twenty-two-bed pavilion for scarlet fever, which contains two one-bedded wards, viewed from the nurses' duty room.
7. Twelve-bed pavilion for diphtheria.
8. Four-bed pavilion for doubtful cases.

These wards are heated by Hendy and Pattison's ventilating stoves, each covered with one slab of Morcan artificial marble, the sides being covered with similar material. Provided these

slabs are laid on asbestos, they answer well, and allow of the stove top being used as tables for flowers, etc.

All heating for lavatory annexes, administrative and receiving and discharging blocks and water throughout the hospital is done by steam brought from the pumping station, and which will be produced by the destructors at a distance of 2200 feet from the hospital buildings.

The main carrying this steam is a 3-inch flanged cast-iron pipe, carried upon wooden posts driven into the ground and coated with non-conducting material which is encased in tarred canvas. The main is above ground except where it passes beneath roads; in such cases it is carried in opuscular pipes or creep ways. All hot-water cisterns have been coated with maquesia, which has obtained most favour as a non-conducting substance.

The steam for the laundry and disinfector is conveyed by this main. The total amount of coal required to supply the steam for all these purposes does not exceed 25 cwt. a day.

The hospital is lighted throughout with electric light, regulating lights being fixed in the ceilings of the wards and used as night lights.

These buildings are all in telephonic communication by means of intercommunication system.

As regards the construction of the hospital, there are a few points to which attention may be called.

(*a*) The site is on clay, which proved far worse than was anticipated, and required the foundations to be carried to greater depths in many cases than were provided for; in the case of one building the concrete was got in for the foundations luckily some months before the brickwork was commenced; two parallel cracks ½-inch in width occurred in this concrete, which was removed and carried deeper; no crack has so far occurred in the brickwork.

(*b*) In the plaster of walls and ceilings, where panier has been used without a backing, no cracks have occurred, whereas, where Keen on Portland was used cracks have occurred.

(*c*) Exposed metal partitions plastered with granitine plaster have been used throughout when not required to support a floor above. For hospital construction these partitions effect a saving.

The drawings on the walls show a number of buildings and works which it will be impossible for the Members to visit to-day, and several works which have not yet been commenced.

In connection with the treatment of sewage is a scheme for four settling tanks each 110 feet long by 30 feet wide, with an average depth of 11 feet. When these tanks are completed there will be a tank capacity of rather more than a dry weather day flow of sewage. These tanks will give an opportunity of trying the effect of septic treatment on the Wimbledon sewage.

Another work about to be commenced is that of the additions to the electrical generating station, plans for which have been prepared to suit the requirements of the electrical engineer.

Plans for additional underground conveniences are also on the way.

Plans of several recreation grounds are given, including South Park gardens, which is now hanging fire on account of the expense.

Most Members of the Association have given considerable attention to the subject of artisans' dwellings, and plans of those erected and let at 7*s.* 6*d.* a week, and those that it is intended to erect, are open for your inspection.

Members will also see plans for flood prevention works, carried out by Messrs. B. Cook and Co. contractors of Westminster, and plans for the middle lower sewer improvement.

DISCUSSION.

Mr. H. York: Can Mr. Cooper give us any information with respect to this new railway bridge, as to the amount of the load and the margin of safety allowed. I should also like to know the initial pressure of the steam conveyed to the isolation hospital.

Mr. James: I notice that in the case of the isolation hospital the women's ward is larger than that of the men. This is a very unusual arrangement of the accommodation at an isolation hospital, and I should like to know whether it is because children up to a certain age are allowed to go into the women's ward.

Mr. Hainsworth: I should like to ask the cost of the artisans' dwellings, and whether the rent of 7*s.* 6*d.* per week covers everything, including cost of land, buildings, repair, and interest on and repayment of loan.

Mr. C. J. Jenkin: I should like to ask Mr. Cooper with respect to this unusually long length of steam pipes, what he does with the condensed waters, and whether the loss of 5 lb. pressure is the total loss of pressure under all variations of temperature. With respect to the provision of bath-rooms, my own experience is that in this class of dwelling bath-rooms are of no use at all. The tenants can get a bath in the kitchen or scullery with an ordinary tub or movable bath, and the provision of a special bath-room is unnecessary. I should like to know the extra cost which the bath-rooms entail; I should also like Mr. Cooper to give separately from the cost of the building the cost of land, for obviously the cost of land varies in each district.

Mr. A. Gladwell: What is the cost per bed of the isolation hospital.

Mr. Shaw: I should like to have the estimated cost of laying out this recreation ground which Mr. Cooper is in the unfortunate position of not being able to get the necessary money to complete.

Mr. F. H. Parr: I should like to ask Mr. Cooper whether in this recreation ground it is necessary to put down land drainage, and what the cost of that will work out at per acre.

Mr. W. Harpur: I have pleasure in formally moving a vote of thanks to Mr. Cooper for his description of the works he is carrying out. And I should like to make a remark or two about the erection of dwellings for the labouring classes. I think the cottages that Mr. Cooper has put up are let at a rental of 7*s.* 6*d.* per week. We have not done anything in this matter at Cardiff up to the present time, but there is a cry for municipal dwellings for the labouring classes. Our difficulty is that if we put up such dwellings they must be built so as to let at a rent of about 4*s.* or 5*s.* per week to prove a success. The ordinary speculative builder in Cardiff provides houses in any number, which let at rents of from 6*s.* 6*d.* to 7*s.* 6*d.* per week, and if we are to provide dwellings for the labouring classes they must be dwellings which will let for a less rental. That is the practical

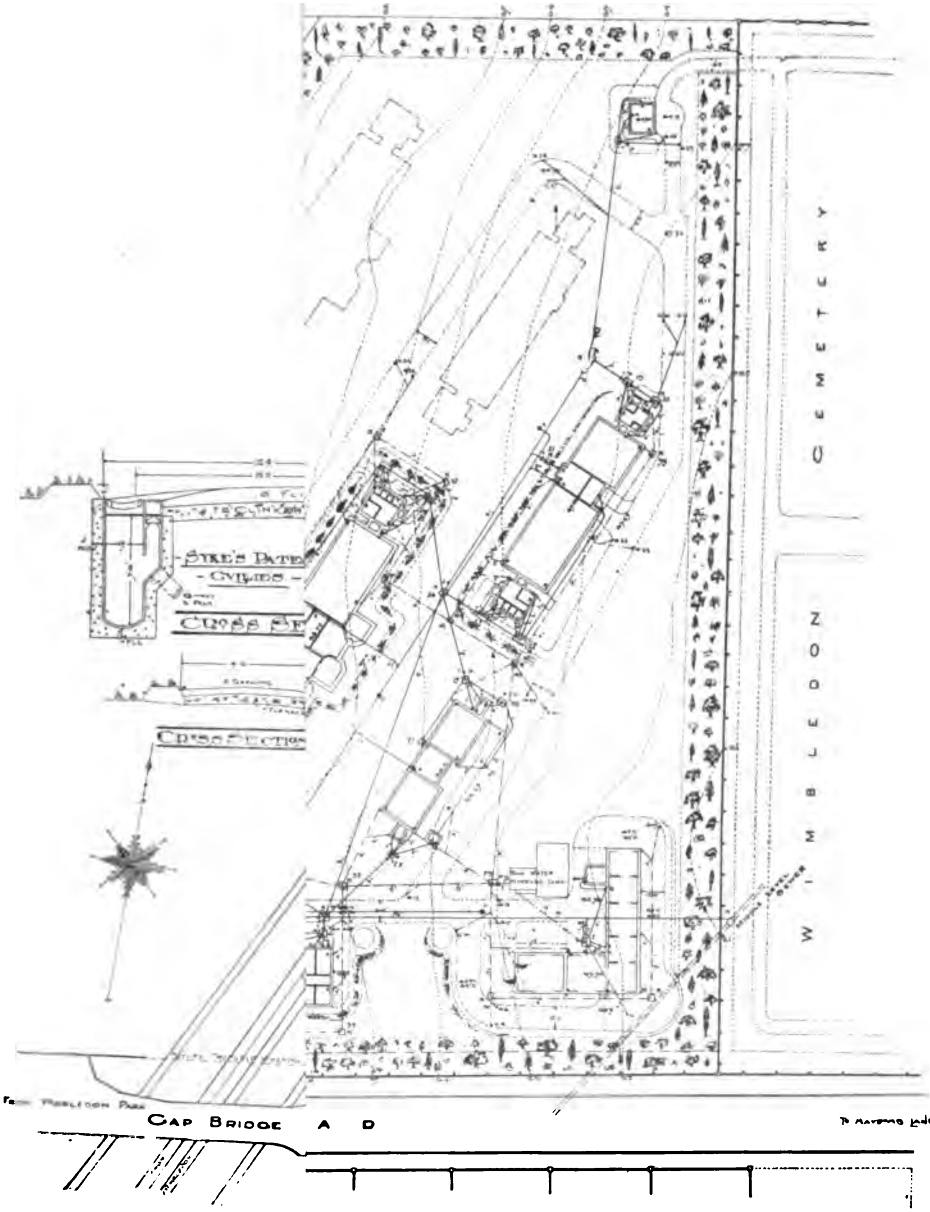
difficulty which will have to be met by local authorities. It seems to me they are asked to do what is almost an impossibility under the present condition of the law, if there is to be no charge on the rates—that is, to provide a house which will let at such a rent as will outdo the ordinary builder. I do not know how it is possible for local authorities with the restrictions imposed on them to do better than is done by the ordinary builders, or even as well. My own opinion is that builders will provide whatever class of house there is a demand for, if allowed by the landowners to erect such houses on their properties, but necessarily the builder must get a profit upon his outlay. When local authorities have paid for the upkeep of the buildings, and interest on, and the instalments in repayment of loan, I do not see how they can expect to be able to do better than the builder who has no repayments of principal to make. It is a very difficult problem and one constantly brought to the front, but how it is to be met by local authorities and not burden the rates with the undertaking I cannot see, and if any gentleman can see how these difficulties are to be got over I shall be very glad for information on the subject. It seems to me that before the municipalisation of dwellings for the labouring classes can become a success it is absolutely necessary that drastic amendments of the Acts of Parliament permitting public authorities to erect artisans' and labourers' dwellings should be made. Until then I do not think it possible that public authorities can satisfactorily cope with the question.

Mr. J. Parker: I have been very much struck by the proposals made here for dealing with artisans' dwellings. It seems to me that there is a most important point to be noted with reference to the provision of artisans'—I prefer to say labourers'—dwellings. In Hereford we are disturbing in the removal of slum areas not so much artisans as the poorer class of labourers. So far as I am able to judge, there are no slums in Wimbledon, so the question is not one which particularly affects this district. From these slums we are evicting tenants who are paying a rent of not more than 2*s.*, 2*s.* 6*d.*, or 3*s.* per week. It is quite true they are miserable hovels. The problem for local authorities is now to provide cottages for the displaced population at rentals within their means without taxing the ratepayers. Hoping to obtain some modification of our bye-laws in connection with labourers' dwellings so as to reduce the cost,

I recently interviewed Mr. Gordon Smith, the architect at the Local Government Board, on this matter. I was in hopes of designing houses which we could build so as to let for a rent of 3*s.* or 3*s.* 6*d.* per week, but after satisfying the requirements of Mr. Gordon Smith, and our own bye-laws, I found that impracticable, and the best and cheapest I could do was to provide houses which let at a rent of 4*s.* 6*d.* per week. That does not meet the difficulty I have referred to, of the poorest class of labourers, and neither London, Birmingham nor Liverpool has solved that problem. Liverpool has come nearer to a solution than any other large town in the kingdom. Mr. Boulnois, when city engineer at Liverpool, did build houses which he could let at a rent of 1*s.*, 1*s.* 6*d.* and 2*s.* per room per week, and that is a better performance than has been touched in London, Birmingham or Wimbledon. As to the settling tanks, I should like to ask Mr. Cooper whether he has thought of converting these tanks into septic tanks and coarse grain filters. With reference to the railway bridge, I have found that the railway companies have a tendency to increase the height of their bridges from the rail level. I may mention that at Hereford we had a case of a goods train travelling from Derby to Cardiff which was improperly loaded, and a segment of a large wheel after passing the first girder, caught the second girder, and swept the remainder of the bridge clean away. Happily it occurred at night and there was no fatal result, but a policeman who was on the bridge at the time had to perform an acrobatic feat to remain on the only girder of the bridge which remained standing. The railway companies undoubtedly have a tendency to increase the height of bridges beyond the original level, thus increasing the gradients to all our bridges.

Mr. C. H. Cooper, in reply, said, I have to thank you very much for your cordial vote of thanks. As regards the railway bridge, the dead weight came to 2 cwt. per foot run and 2½ cwt. of light load was allowed for, making a total of 5½ cwt. per foot. The initial pressure of the steam when admitted to the hospital main is 50 lb., its loss *en route* has been 5 lb. at times. The condensed water passes into the well from which the laundry water is taken. As regards the women's ward at the Isolation Hospital, the answer is self evident. It is that the small children are admitted into the women's ward. As to the cost per bed it is rather high at present, but I have

PLATE I.

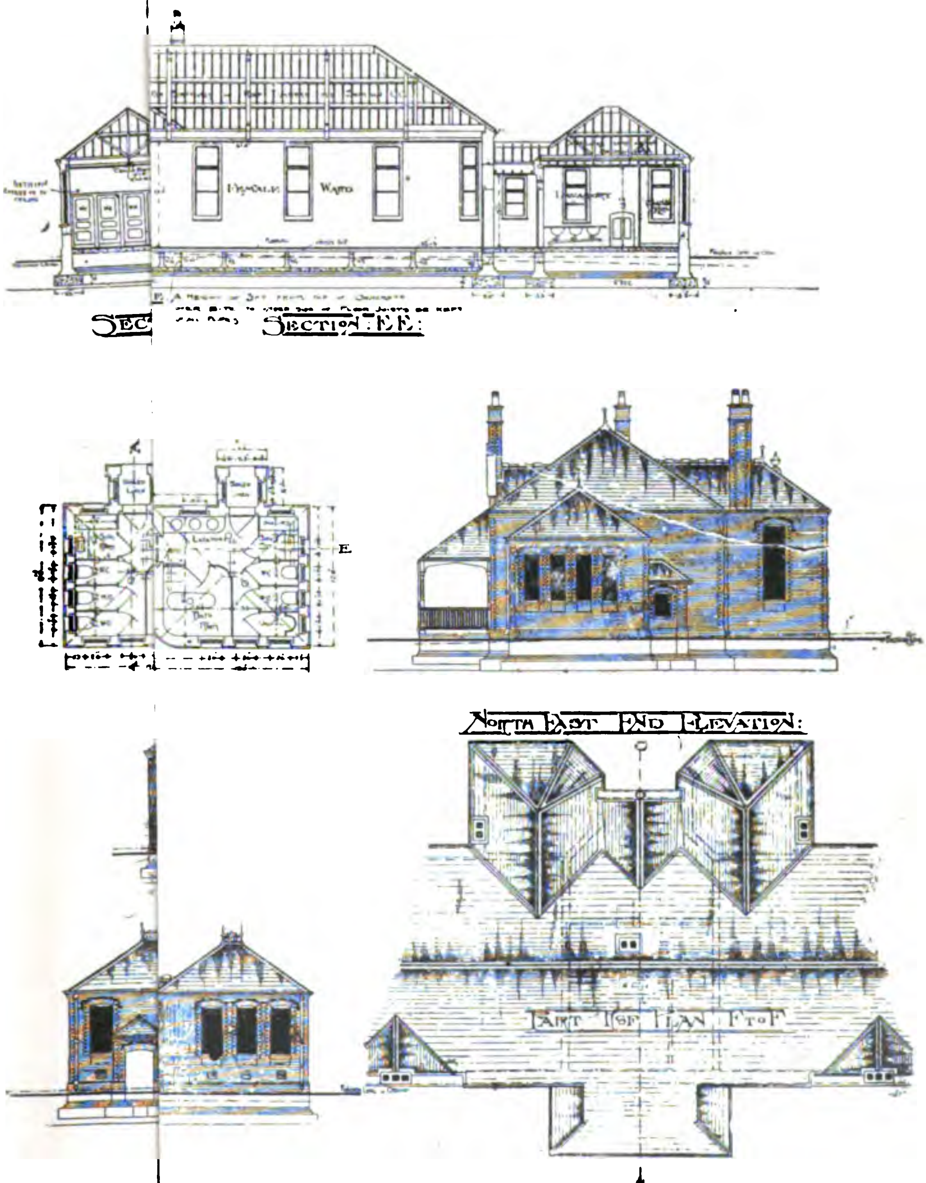


Scale : Block Plan, 96 ft. to 1 in.; Sections, ¼ in. to 1 ft.

WIMITE SHOWING DRAINAGE.

Reference : h-air Inlet. **H**—Hydrant. **S V**—Stop Valve.
te. **R**—Rain-water Pipe.

PLATE 11.



TY-TWO BEDS.

had the cost of other hospitals constructed recently, and it is under this. In a hospital of this kind, it has to be remembered that provision is not only made for a certain number of beds, but also for an administrative block and offices for a still greater number of persons, and when the question of providing another pavilion comes up for consideration, it is my intention to suggest a large pavilion with forty-four beds. When that is done the cost per head will be very much reduced; but, as I have said, at present they are high and must be, but when the hospital is completed I anticipate the cost per bed will not amount to 400*l.* With respect to the artisans' dwellings, those we have erected cost 270*l.* each. These cottages are better than those now letting in Wimbledon at 9*s.* 6*d.* per week, so we are giving a better cottage with more room in it at 2*s.* per week less than those belonging to private owners. As regards the question of bath-rooms, Mr. Jenkin's allusion to a movable bath in the scullery, although finding favour with the Local Government Board, is not a suggestion the Author can approve of either from the point of cleanliness or morals; it cannot be in the interest of health to wash a possibly diseased body in the same room in which food is prepared for others.

The Members after inspecting the new railway bridge which was in course of construction, lunched together under the presidency of Mr. Lowe.

The afternoon was devoted to an inspection of the Isolation Hospital buildings, the wards and administrative block, and the destructor at Streatham. A visit to the Fulham Electricity Works concluded the proceedings of the day.

DISTRICT MEETING AT OSWESTRY.

May 18, 1901.

Held in the Guildhall, Oswestry.

CHARLES H. LOWE, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Mayor of Oswestry (Richard Daniel, Esq., M.P.) received and very heartily welcomed the Members to the town.

Mr. Parry Jones, Town Clerk, Dr. Aylmer Lewis, Chairman of the Sanitary Committee, Councillor Smith, Chairman of the Markets Committee, and Mr. T. Whitfield, Chairman of the General Purposes Committee, joined in the welcome extended to the Association.

The President thanked the Mayor and the other Members of the Corporation for their kind welcome.

Mr. J. S. Pickering was unanimously re-elected Honorary Secretary for the Midland District.

The following paper was then read and discussed:—

OSWESTRY MUNICIPAL WORK & PROGRESS.

BY G. WILLIAM LACEY,
BOROUGH ENGINEER AND SURVEYOR.

IN inviting the Association to pay this, its first visit to the town of Oswestry, and in preparing his first paper for them, the Author does so with a considerable amount of diffidence, but at the same time desires to express the hope that the meeting will not prove an uninteresting one; and also his gratification at the honour paid to the town and himself.

The paper will be general in its scope, but dealing more particularly with works which have been carried out, or are being so, during the two and a half years the Author has held his appointment; and it will be seen, taking into consideration its size and situation, that Oswestry cannot by any means be designated an unprogressive town.

Historical.

As the town is one of considerable antiquity, a short account of its history may be of interest, and the Author quotes from some writings on the subject by J. Parry Jones, Esq., Town Clerk:—

"The history of the town is singularly fruitful in interesting associations from the earliest periods down to the time of the Commonwealth. Tradition names old Oswestry or Hen Dinas—a wooded eminence situate within a mile from the town, and one of the finest British emcampments in England—as the birth-place of Guinevere, the heroine of Tennyson's 'Idylls.'

"Some centuries later, in 642, Oswald, king of Northumbria, was defeated and killed on the site of Oswestry by Penda, the pagan king of Mercia. In the grounds of the grammar school there still exists Oswald's well, which legend tells sprung on the spot where the saint was killed. The name of the town is a corruption of Oswaldstre (i.e. either the Tree of Oswald or Oswald's Town).

"The fragmentary remains of the castle are situate upon the castle bank (now laid out as a public recreation ground). Its position must have been one of great strength, even to a late period, and when captured by the Parliamentary forces in 1644 it was described as 'the key of Wales.' It was erected or enlarged at the time of the Norman conquest, and was granted by William the Conqueror (who visited Oswestry in 1068) to Alan Fitz Flood. He was the first of the great Fitzalan family who for centuries were lords of Oswestry. About the year 1160, Walter Fitzalan left Oswestry castle and took refuge in Scotland at the court of David I., King of Scotland, and became steward or seneschal to the king; and Sir Walter Scott points out that he became the founder of the Royal House of Stuart, and, through them, of the present Royal Family. William Fitzalan granted the first charter to Oswestry in 1190; but

the first Royal charter (still in excellent preservation among the archives of the Corporation) was granted by Richard II. in 1398. In addition to the charters already mentioned, charters were granted by Queen Elizabeth, James I., and Charles II., which are still preserved."

The walls, which originally surrounded the town, were erected by Edward I. Pennant says that, having resolved upon the conquest of Wales, the king "thought proper to secure this town, one of the keys of the country, with proper defence." The walls were about a mile in circuit, and there were four gates, one at each entrance to the town. The last of these were demolished in 1782.

General Statistics.

The area of the Borough is 1888 acres, and the estimated population at the present time is 10,000.

The following table shows the growth of the population since 1851:

Year.	Population.	Year.	Population.
1851	4817	1881	7851
1861	5414	1891	8496
1871	7808	1901 (estimated)	10000

The town is situated in the north-west corner of the county of Shropshire, and is distant 191 miles from London and about 60 miles from Manchester, Liverpool and Birmingham. It is an important market centre, drawing large quantities of all kinds of cattle and agricultural produce from within an extensive radius. The railway services are the Cambrian, their chief offices and works being here, and the Great Western (branch).

The Municipal Buildings, a handsome structure in the Renaissance style, faced with Grinshill stone, were erected in 1892 from the designs of Mr. Cheers of Twickenham, with modifications by Mr. T. M. Lockwood of Chester, the consulting architect to the Council, who eventually superintended the erection of the buildings, which cost 12,000*l.*

The accommodation provided consists of the council chamber, town clerk's, borough surveyor's, finance clerk's, and county court offices, on the ground floor; court room, magistrate's room, magistrate's clerk's office, solicitor's room, assistant overseer's office and the public reading rooms, on the first floor;

lending and reference library, and other rooms which were originally used for science and art classes, on the second floor. The caretaker's apartments, etc., are situated in the basement.

The science and art classes having outgrown their accommodation in the municipal buildings, the old British School in the immediate vicinity, which was particularly suitable, was purchased in 1898. This building was refronted and otherwise adapted, at a cost of 661*l*., and now forms a commodious Science and Art School.

Mr. E. Bremner Smith, of Oswestry, was the architect for this work. The cost was met by a grant from the County Council, public subscriptions, and the remainder by the Town Council.

The town of Oswestry has the reputation of being the healthiest in the county with the exception of Newport, which is however only one-third the size. The following are the vital statistics for the last two years:—

Year.	Death Rate.	Birth Rate.	Zymotic Rate.
BOROUGH OF OSWESTRY.			
1899	15·6	25·2	0·92
1900	16·0	24·0	0·41
COUNTY OF SHROPSHIRE (URBAN).			
1899	18·4	29·1	1·30
ENGLAND AND WALES.			
1899	18·3	29·3	2·20

WATER SUPPLY.

The water supply is derived from a gathering-ground in the hills of Denbighshire, 5½ miles distant from Oswestry. Prior to the construction of the impounding reservoir there was only a small catch-tank in addition to the service reservoirs, so that without proper storage the supply was somewhat precarious in the summer months.

The reservoir is formed with an earthern embankment, Mr. Henry Rofe being the engineer for the work. Tenders were

obtained in 1886 and also in 1888, when the work was gone on with, but the contractor failing to carry out his contract, the completion of the reservoir was undertaken by the Corporation, under the direction of Mr. Rofe. The amount of the tender for the construction of the reservoir was 9341*l.*, but by the time it was completed the cost had reached no less a sum than 21,806*l.* It has a capacity of 24,000,000 gallons, which is equal to 117 days' supply at the present rate of consumption.

From the impounding reservoir the water is delivered into three open service reservoirs, which have a total capacity of 6,000,000. The embankments of these having become in a state of disrepair, the Town Council are now considering the question of their reconstruction, which will entail a very considerable outlay.

The top-water level in the impounding reservoir is about 1090 feet above Ordnance Datum, and that in the service reservoirs 694 feet above O.D. The lower levels in the town touch 380 feet above O.D.

The water is of very good quality, but contains peat, which naturally affects the colour, but not its purity or suitability for dietetic purposes.

On account of the peaty nature of the water it is necessary to scrape the main, from the impounding to the service reservoirs, three or four times a year, and on each occasion the scraper is passed at least twice through the main. The cost of this scraping works out at about $\frac{1}{10}d.$ per yard lineal.

During the past two and a half years the Author has laid down extensions of the water mains a mile in length.

The average yearly rainfall in Oswestry is about 36 inches, and at the impounding reservoir it is from three to four inches more.

New Streets and Buildings.

New bye-laws have recently been adopted, after some years of consideration and discussion with the Local Government Board with a view of certain concessions.

For a small town in an agricultural district, the growth, particularly during the latter half of the past decade, has been fairly rapid. Several new streets have been laid out and wholly or

partly built upon, and the following table shows the number of houses erected during the ten years ended 1900:

Year.	No. of Houses erected.	Year.	No. of Houses erected.
1891	2	1896	92
1892	7	1897	41
1893	29	1898	26
1894	23	1899	100
1895	80	1900	46

Streets and Roads.

There are 12 miles of streets and roads within the borough. The carriage-ways are macadamised with Clee Hill granite, Glyn and Ceiriog granites, and a small proportion with limestone. The first is used on roads subject to heavy traffic, and the others on those which bear a lesser amount of traffic. The Council possesses an Aveling and Porter's 10-ton steam roller, and have just decided to purchase, on the Author's recommendation, a Morrison's scarifier.

There are 5 miles 5 furlongs 140 yards of main road, towards the maintenance of which the County Council now pays the sum of 650*l.* per annum. Up to 1899 they contributed the sum of 517*l.* per annum, and the Town Council applied for an increased grant based upon the average cost during the last four years, which was 846*l.* per annum. The County Council eventually offered the sum of 650*l.* on an agreement being entered into for a term of seven years.

The older footways are paved with York stone and blue chequered tiles, but during later years concrete flagging and tar-paving have been more generally adopted. The tar-paving which the Author lays, consisting of 2 inches of tarred limestone (1 inch gauge) and 1 inch of tarred limestone chippings (½ inch gauge), dressed on the surface with dry limestone dust, costs 1*s.* 9*d.* per yard super; 3½ inch by 12 inch dressed limestone kerbing delivered costs 2*s.* 6*d.* per yard lineal; 10 inch by 6 inch limestone channel slocks, 1*s.* 8*d.* per yard lineal; Clee Hill 4 inch cubes, 1*l.* 4*s.* 1*d.* per ton; Clee Hill macadam (2 inch gauge), hand-broken, 10*s.* 1*d.* per ton, machine-broken, 9*s.* 7*d.* per ton; Glyn and Ceiriog granites, 7*s.* per ton; concrete flagging, 3*s.* 6*d.* per yard super.

Sewerage.

The main sewerage system was constructed in the year 1867, Messrs. Gotto and Beesley being the engineers. The main outfall sewer is an egg-shaped brick culvert, 3 feet 9 inches by 2 feet 6 inches, and the other main arterial sewers are 3 feet by 2 feet and 2 feet diameter brick culverts, the remaining sewers being of glazed pipes from 15 inches to 9 inches diameter. Water-closets are general.

Practically the whole of the surface water is received into the sewers, and this is augmented a good deal by springs, some of which exude on the road surfaces.

All the sewers have self-cleansing gradients, and there are nine flushing chambers, with automatic syphons, ranging in capacity from 350 gallons to 1350 gallons. These automatic syphons are not found to work satisfactorily with a small flow of water, and a man is sent round weekly to complete, if necessary, the filling of the chambers, and to see that the flush takes place. The sewers are also flushed at other points than where there are flushing chambers.

The sewers are ventilated by means of seven circular cast-iron shafts in various parts of the town, and the manhole and lamphole covers, which are not numerous on the old system, are mostly of the closed type.

The earlier pipe sewers are laid with ordinary glazed socketed pipes and chiefly jointed with clay, but on the Author's suggestion for adopting a better class of joint his council decided to use Stanford jointed pipes and to require those or other approved pipes to be used in any new streets laid out.

A fair amount of work in connection with the sewers has been carried out during the past two years, several having been extended to meet requirements of new buildings. Flooding of cellars during heavy storms having been of frequent occurrence in two streets, the circumstances were investigated, and in the one case the cause was found to be the inadequate size of the sewer at the lower end of the street owing to the gradient being much flatter than in the upper. An additional or relief sewer 18 inches diameter was laid for a length of 138 yards, and for the greater part of the distance alongside the original sewer, with which it joins at a manhole with a weir 5 feet long, the

invert of the new sewer being 6 inches below that of the old. The cost of this work was 142*l*. In the second case, the cause was ascertained to be owing to the sewer being in places almost wholly choked on account of the irregularity in the gradient and general faultiness. This sewer for a length of 134 yards was replaced with 15 inches and 12 inches diameter Stanford jointed pipes laid to an even gradient of 1 in 80, which, with three manholes, cost 145*l*.

There is a small district below the gravitating level of the main system the sewage from which delivers into a chamber from which it is lifted by a 3-inch Johnson's drum pump driven by a 3 horse-power electric motor. The sewage is discharged through a 4 inch cast-iron rising main into a gravitating sewer 580 yards distant, the total lift being 34 feet. This work was carried out by the Author's predecessor, the cost of the motor, pump, rising main, etc., being about 220*l*. The cost of working and maintenance is rather heavy.

Refuse Collection and Disposal and Scavenging.

The daily collection of house refuse throughout the town is in operation, the ashpit system having been abolished and the present one inaugurated in 1895.

At the present time the work engages regularly two sets of teams and men on five days in the week, three on Saturdays, and also an additional team for half-a-day on two other days. In addition to collecting the house refuse, the carts, on their rounds, also pick up the dry sweepings from the streets.

The method of disposal which has been in vogue for a great many years is by tipping, but this cannot be characterised as satisfactory in these days, except under exceptional conditions. The sanitary committee have had, at various times, under their consideration the question of a refuse destructor, but have come to the conclusion that it is too costly for a town of this size where there is no particular use for the heat generated.

The cost of collection and disposal is about 325*l*. per annum, and the quantity collected is approximately 2600 one-horse loads per annum, which is equal to 2*s*. 6*d*. per load. This somewhat high figure is partly attributable to the distance the refuse has to be carted, viz. a mile from the centre of the town.

The normal staff engaged in street scavenging daily comprises two men, each with hand-carts, who patrol the centre of the town, and two men with brooms who cover daily practically every street. This is, of course, considerably augmented in wet weather and at other times when the horse brush is used, which is of very frequent occurrence.

Street Lighting.

The streets are lighted by means of 220 gas-lamps burning at the rate of 5 cubic feet per hour. Some forty-three Welsbach incandescent burners have been fixed in various streets. The gas-works are in the hands of a company, who light, extinguish and maintain the lamps at a charge of 3*l.* per lamp per annum.

Electric Lighting.

Electric light works have been established five years and are in the hands of a company. Last year negotiations were entered into with a view to purchasing the undertaking, but, for reasons which need not be stated here, this met with considerable opposition, and the result of the Local Government Board inquiry which was held was against the sanction being granted.

Sewage Disposal Works.

The bacterial sewage disposal works were designed and partly carried out by the Author's predecessor (Mr. R. O. Wynne Roberts) and completed under the supervision of the Author in June 1899. They have been constructed by direct employment of labour, and the cost has been met out of current revenue.

Prior to the construction of these beds the system of treatment was very crude, the sewage simply running through two settling tanks and away. In 1895, Messrs. John Taylor, Sons and Santo Crimp, civil engineers, submitted a report on the question recommending a scheme which, including the purchase and laying out of 51 acres of land and works for dealing with the sludge, was estimated to cost 15,000*l.*, but on account of the cost this was not entertained. In October 1896 the Author's predecessor submitted a report, and finally it was decided to commence an experiment on the lines carried out by Mr. Dibden at Sutton. This, after several months' trial, proving a success,

it was decided to carry out a complete scheme and the present works were commenced.

There are nine primary beds, the surface area of each being 60 feet by 60 feet, and nine secondary beds, each with a surface area of 60 feet by 50 feet, and they are constructed partly in the natural ground, and partly by earthen embankments, which are 11 feet wide at the bottom and 2 feet 6 inches wide at the top. In the secondary bed embankments clay puddle was put as a security against percolation. On the floors of the beds, lines of 3 inches diameter agricultural pipes, a yard apart, are laid connecting with brick channels, which terminate in a small brick chamber in each bed, with the exception of the central ones, where they connect with a channel around the valve chambers. From these brick chambers 9-inch glazed pipes are laid to the valve chambers, for discharging the effluents. The beds are filled with cinders which were riddled from an old and large accumulation of house refuse; the gauge of those in the primary beds being from $\frac{3}{8}$-inch to $1\frac{1}{2}$ inch, though containing very little of the larger size, and in the secondary beds from $\frac{3}{8}$ inch to 1 inch. The depth of the cinders is 4 feet 6 inches in each series. In the centre of each series there are automatic valves, which were designed by Mr. Wynne Roberts, in conjunction with Mr. Henry Roberts, water inspector, worked by water pressure from the town mains, which distribute the sewage and primary effluent to the various beds in rotation; hold up the sewage, etc., in contact in the beds and discharge the effluents in due course.

Since the completion of the beds, it has been found necessary to put in aëration pipes from the ends of the collecting channels to the surface, in order to facilitate the discharge and complete drainage of the contents of the beds, and this has had a beneficial effect.

The primary beds have since the commencement of their full use been reduced in capacity by about 30 per cent., but no further decrease has been observed for some time; if anything, since the aëration pipes referred to have been fixed the capacity has increased, and certainly the results have been somewhat better than before. No appreciable decrease has taken place in the capacity of the secondary beds.

The sewage first of all passes through one or both of the two settling tanks, 70 feet by 15 feet by 4 feet 6 inches, and in

these a considerable quantity of sludge precipitates, no chemicals being used. The sewage and primary effluent are distributed over the beds by means of wood troughs, and the final effluent passes away through 12-inch diameter pipes and discharges into a small watercourse.

The sludge from the settling tanks is pumped out at intervals of from eight to ten weeks, mixed by machinery with fine screened ashes, and finds a ready sale to farmers at 6*d.* per load. It is not contended that this part of the process is ideal or one which it is desirable to continue, but at the present time it serves to dispose of the large accumulation of screened ashes (the fine residue from the riddling), which otherwise would be more or less—somewhat of a white, or rather in this case, a black elephant. The Author some time ago recommended his sanitary committee to consider the advisability of adding septic tanks, and in all probability this may eventually come to pass.

The quantity of sewage dealt with in the course of a year is about 160,000,000 gallons, the average daily flow in 1900 being 440,000 gallons, and the dry weather flow 387,000. This includes a considerable quantity of spring or surface water which finds its way at some points into the sewers, as otherwise the dry weather flow should not be more than 250,000 gallons per day. Notwithstanding this dilution the sewage, as the analyses show, is very strong, containing as it does a considerable proportion of brewery, tannery and fellmongers' refuse.

The following are a fair sample of a large number of analyses made by the Author from time to time. The occasional analyses made of the effluent from the primary beds go to show that a remarkable proportion of the purification is effected by the first contact.

Samples of the effluents which have been kept for longer than a year, show no signs whatever of putrescence, and analyses made during very severe winter weather, showed but a slight diminution in the degree of purification. This diminution is but natural, as when the beds are partially covered with a sheet of frozen snow, the admission of air into the beds must of necessity be retarded; but this lessening of aëration is not likely to be of sufficient duration to materially affect the results. Records of temperatures taken during severe weather, showed that not only the sewage, but the interior of the beds, both when full and empty, were several degrees above freezing point.

BOROUGH OF OSWESTRY.

ANALYSES OF SEWAGE AND EFFLUENTS.

Date.	Sewage.				Effluent.				Percentage of Purification.	
	Chlorine.	Free Ammo.	Alb. Ammo.	Oxy. Abs. in 20 min.	Chlorine.	Free Ammo.	Alb. Ammo.	Oxy. Abs. in 20 min.	Alb. Ammonia.	Oxygen Absorbed.
1899.		grains per gallon.				grains per gallon.				
August 28 ..	7·5	4·20	0·795	2·8	6·5	0·49	0·091	0·21	89·8	92·5
September 16 ..	9·0	5·42	1·82	3·5	8·5	0·35	0·126	0·28	93·0	92·0
October 11 ..	7·0	3·08	1·302	1·96	8·0	0·49	0·134	0·28	89·6	85·7
November 18 ..	..	3·50	1·176	2·52	..	0·378	0·105	0·35	91·0	86·1
December 4 ..	6·0	2·10	0·924	2·24	6·5	0·154	0·09	0·25	90·2	89·0
„ 22 ..	5·5	1·68	0·84	2·38	5·5	0·126	0·084	0·252	90·0	89·4
1900.										
January 2 ..	7·0	2·52	0·798	2·10	4·8	0·296	0·084	0·22	89·4	89·4
April 10 ..	7·0	3·57	1·344	2·52	6·0	0·462	0·168	0·294	87·5	88·3
„ 16 ..	5·5	3·22	1·056	2·66	5·0	0·35	0·13	0·336	87·6	87·4
July 5 ..	7·25	1·68	1·596	3·92	6·25	0·336	0·196	0·49	87·7	87·5
September 7 ..	14·0	4·90	1·428	5·18	9·0	0·504	0·168	0·518	88·2	90·0
October 2 ..	6·8	5·32	1·176	3·92	6·0	0·578	0·147	9·476	87·5	87·9
1901.										
January 22 ..	4·4	2·66	1·26	1·96	3·4	0·154	0·1218	0·28	90·3	86·0
February 15 ..	7·0	2·24	0·966	3·50	4·5	0·14	0·088	0·28	90·9	92·0
March 15 ..	6·25	1·96	0·966	2·10	5·0	0·112	0·0756	0·21	92·2	90·0
„ 27 ..	6·0	2·10	0·756	2·10	6·25	0·224	0·0756	0·238	90·0	88·7
April 23 ..	5·5	3·78	1·428	2·24	5·5	0·168	0·109	0·252	92·3	89·0

The cost of the construction of the bacteria beds and other work in connection therewith, has been slightly over 2000*l.*, or equal to the sum of 4*s.* per head of population.

The net cost of maintenance at the present time, including sludge disposal, is about 225*l.* per annum, or equal to 5½*d.* per head of population. It is expected that this cost will be materially reduced ere long as the automatic valves are being improved so as to render them more dependable, as up to the present it has been necessary to have a man on the works during the night.

As before stated, the cost of the construction of the works was defrayed out of revenue, but not the cost of the land acquired, and on June 2, 1899, a Local Government Board inquiry was held, sanction being sought to borrow the sum of 3500*l.* to cover the above and other additional expenditure. This was not obtained as our works did not allow for dealing altogether with six times the normal flow of sewage, and for after treatment of the effluent on land. This result, however, knowing the attitude of the Local Government Board on the subject, was no more than need have been expected.

Markets.

The buildings for market purposes consist of the Cross Market and the Powis Hall. The former is the chief, and accommodation is provided for all kinds of agricultural produce, such as poultry, eggs, butter, rabbits, etc., and for meat, fish, fruit and greengrocery.

The original Cross Market was built in 1849 and covered an area of 870 square yards. In 1879 a Provisional Order was obtained and 10,000*l.* was borrowed for the purchase of properties and extending the market. In 1880 it was considerably enlarged, covering an additional area of 691 square yards. At a later period further accommodation being necessary and looking forward also to future requirements, the Town Council in 1897 applied for another Provisional Order enabling them to purchase other properties which would allow them to extend the market buildings, and also to effect some important street improvements. These properties were purchased at a total cost of 8600*l.*

The extent and character of the proposed enlargement of

the Cross Market having been discussed for some time, it became the Author's duty, on taking up his appointment, to prepare plans and specifications for the work which is now in progress under his supervision. This includes the addition of two wings, one having a frontage to Willow Street and the other a frontage to the new street which has been constructed in connection with these improvements, and they cover an area of 570 square yards.

The new buildings are faced externally with Ruabon pressed red bricks with Cefn stone dressings, etc. The roofs consist of mild steel principals with wood purlins and V-jointed boarding, and are covered with Bangor slates; a lantern of wood framing and louvres made to open and close for ventilation runs along the centre of the roofs, and is covered with Pennycook's patent glazing. The inside walls of the butchers' market are faced with white glazed bricks to a height of 9 feet, with a brown moulded capping at the top. The inside walls of the small fish-market and of the ladies' lavatory are also similarly faced to a height of 6 feet 6 inches. The floors of the latter are of cement-concrete 7 inches thick supported on steel joists, there being a basement under. The floors of the other buildings are paved with brindled blue bricks laid on a bed of sand on 4 inches of cement concrete and grouted with cement. Collapsible gates are provided to all the main door openings (except one), and these and the ornamental wrought-iron grilles also have been supplied by the Bostwick Gate and Shutter Company.

The contract also included the re-roofing and re-flooring of that portion of the market built in 1849. These new roofs are constructed to match those of the 1880 extension, and consist of composite principals with 10½ inches by 6 inches pitch-pine rafters, cast-iron struts, heads and shoes and steel tie-rods supported in the centre, in the case of the double-span portion, on cast-iron columns. Lanterns for light and ventilation are provided of the same construction as those before described, and the roofs are similarly covered.

The market is lighted by electricity.

It being necessary to provide lavatory accommodation for gentlemen in connection with the market, and a great want also being felt for such by the public, it was decided to construct an underground convenience. This is under the footpath in the Cross and is easily accessible both from the market and

from the street, but owing to the very limited space and depth at disposal the arrangement of the fittings is not quite what could otherwise have been. The walls inside are faced with white-glazed bricks, and it is covered with Hayward's pavement lights and concrete. The whole of the sanitary fittings have been supplied by Messrs. Duckett and Son, as also for the water-closets in the ladies' lavatory, and there has been no attempt at elaboration in this work, costly fittings not being deemed necessary for the purpose which is answered well by those adopted. The contract for the market extensions, etc., was placed in the hands of Mr. W. H. Thomas of Oswestry, the amount of the tender being 4990*l.* 11*s.* 9*d.*

The Town Council also have under their consideration the erection of a further extension in the form of an arcade providing eight or nine lock-up shops, for which the Author has prepared a preliminary design and which is roughly estimated to cost 2000*l.*; the idea in view being that if in the future more market accommodation should be required this building could be utilised for that purpose.

The Powis Hall provides accommodation for the monthly wholesale butter and cheese fair, and on other market days miscellaneous products, also for the weekly corn market. The front portion of this building was erected in 1849, and was very considerably enlarged in 1875.

The Smithfield, which is one of the largest in Shropshire, and to which weekly a large quantity of cattle of all kinds is brought, covers an area of 2¾ acres. The cattle pens are constructed with cast-iron posts and wrought-iron rails, and are chiefly paved with granite cubes; the sheep and pig pens are constructed some with all wrought-iron divisions and others with cast-iron pillars and wrought-iron rails, all being paved with bricks. The roadways are tar-paved. The tolls of the whole of the markets are let, and the following figures show their growth and value.

Year.	£.	Year.	£.
1860	440	1890	1530
1880	1225	1900	1765

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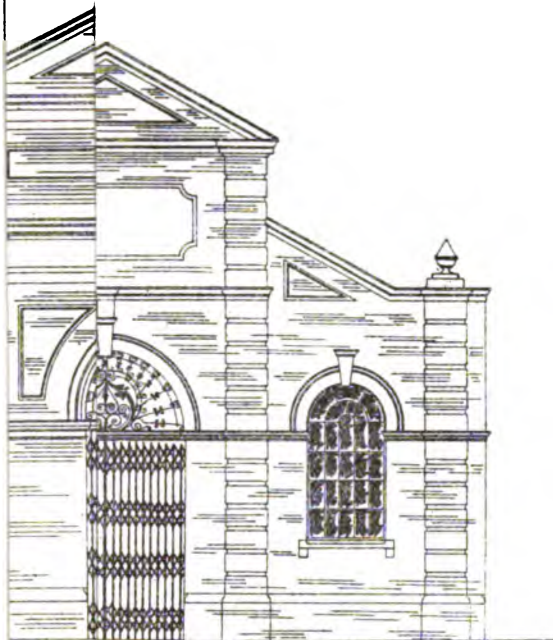
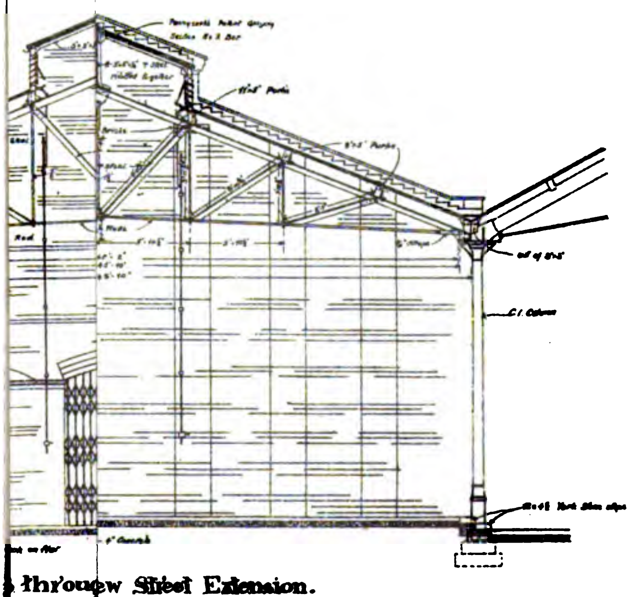
Scale

PHOTO-LITHO. SPRAGUE & C? LTD 4 & 5. EAST HARDING STREET, FETTER LANE, E.C.



vation New Street.

G. William Lacey. C.E.
Borough Engineer & Surveyor.



through New Street Extension.

PHOTO-LITHO. SPRAGUE & Co. LTD. 4 & 5. EAST HARDING STREET, FETTER LANE, E.C.

Fire Station, Stables, Stores, Cart Shed and Mortuary.

These buildings are now in course of erection, all under one contract. They are faced externally with local red wire-cut bricks and the stonework in connection therewith is Cefn. The roofs, with the exception of the cart shed, are covered with Bangor slates.

The fire station comprises an engine house 29 feet 6 inches by 18 feet, with three doorways on to the horse market, providing accommodation for the steam fire engine, one manual engine and a hose-cart, and also a firemen's dressing room 18 feet by 9 feet. The floor of the former will be of concrete in situ and of the latter wood blocks. Another design for a fire station, only of a more pretentious character, on another site was prepared by the Author, but this was relinquished as being more costly than the Council were prepared for. In connection with the fire station a mast with hoisting tackle will be provided for hose drying purposes.

The stables consist of one loose-box and one stall as an adjunct to the existing stabling already on the site and are not for fire brigade purposes, the engines being horsed by contract. Two small stores for highway and waterworks purposes are included in lieu of the old wooden places previously existing.

The cart shed, 58 feet by 34 feet, will cover the greater portion of the yard, and is roofed with galvanised corrugated iron supported on wood queen post principals and purlins.

The mortuary is 14 feet by 10 feet 6 inches internal dimensions, the inside walls for a height of 4 feet being faced with white-glazed bricks with a blue border at the top, and the upper part of the walls will be distempered. The floor will be of concrete and a mortuary table with a dished slate slab and also a combined sink and lavatory will be provided. The building will be ventilated with a Boyle's ventilator on the roof and two air inlet brackets.

These buildings are from the Author's design, and the amount of the contract was 539*l.*, made up as follows:—

	£
Fire station	220
Stables, stores and cart-shed	245
Mortuary	74

Gymnasium.

This building was erected some twenty years ago, and was vested in trustees until three years ago, when it was handed over to the Town Council for their management, it having become in a very dilapidated condition, the corrugated iron roof covering being leaky and the windows mostly broken.

In 1899 the Author prepared plans and specifications for strengthening the walls, constructing an entirely new roof covering of wood purlins, boarding and slates, with a central glazed lantern, distempering walls, painting, glazing and general repairs, which work was carried out at a cost of 585*l.* The roof is supported by the old wrought-iron principals, which were naturally still in good preservation. The main hall is 100 feet by 48 feet 6 inches, and there are two dressing rooms adjoining. The buildings are lighted by electricity.

Proposed Swimming Bath.

Plans for the construction of a swimming bath within the gymnasium, boiler-house and chimney shaft, laundry, dressing box annexe and attendant's room and new entrance have been prepared by the Author, the amount of his estimate being 1700*l.*

It is proposed to construct the swimming bath, which will be 75 feet by 27 feet, with cement concrete walls and floor lined with Callender's bitumen sheeting and faced on the inside with white-glazed bricks. A York stone coping will be put at the top and the floor around the bath will be of granolithic concrete. The system of heating recommended and adopted is the "Rosher," which is doubtless familiar to most, and which has been found to give most satisfactory results.

The boiler power proposed is 20 nominal horse-power and will consist of a steel Lancashire boiler, 16 feet by 5 feet 6 inches diameter, and the chimney shaft will be 50 feet high. The laundry will contain a hand-washer, two washing-trays and a drying closet. The space for these buildings being very limited, the best use has had to be made of it. The dressing-box annexe will contain seventeen dressing-boxes and also a dressing-form with seats and clothes-pegs on both sides which will accommodate thirty. A soap-bath with overhead shower is proposed

to be provided in this building. The lavatory accommodation will consist of a water-closet and a three-stall circular back urinal for males, and a water-closet (already built) for the use of ladies.

To enable the building to be used for gymnastic purposes during the winter months a movable floor will be provided. This flooring will consist of 9-inch by 2-inch red deals made up in sections and supported over the bath on sixteen timber trusses with longitudinal joists.

Application having been made to the Local Government Board for sanction to borrow the money for carrying out this scheme it met with the answer that they had no power to sanction the construction of a swimming bath in a gymnasium, although it is not forbidden to convert a swimming bath into a gymnasium. Truly the ways of the Local Government Board are, at times, past comprehension.

The position arose, apparently, from the fact of the building having been handed over to the Town Council in the way it had been, and by some stretch of imagination, it was looked upon in the light of a charity; at any rate the Charity Commissioners had to be approached, and on the consent of the original trustees being obtained, the Commissioners have prepared a short scheme, of which public notice had to be given, to make it possible for the Local Government Board to sanction the expenditure, and the holding of their inquiry is now awaited. This result even has not been arrived at without considerable pressure, several interviews and lengthy correspondence by the Town Clerk, the original application to the Local Government Board having been made in July of last year.

Public Street Improvements.

For years past every opportunity has been taken to effect street improvements, one of the most important having been the widening of Cross Street, in the centre of the town, from a width in the narrowest part of 15 feet 6 inches to 30 feet. This was effected in 1880, the properties being purchased for the purpose and sold after taking off what was necessary for the improvement.

The chief among those carried out by the Author have been the widening of Llwyn Road, from a width of 18 feet to 36 feet,

the land being given up by the owner; the making up of the new portion of the street being about 200*l*. The much needed widening of a portion of Albert Road, some 180 yards in length, from widths varying from 15 feet to 19 feet to 30 feet for the greater part, and from 22 feet 6 inches to 26 feet 6 inches for the remaining length. This improvement has been carried out at a cost including the purchase of the land, making up the street and other work in connection therewith, of slightly over 1000*l*. The widening of a portion of Oak Street, which was, in part, only a footpath, a portion of the land for which was given up by two owners and the greater part taken from the Recreation Ground (from which also at the opposite side land was given up to form the adjoining street, 36 feet wide). The street construction, etc., in connection with this improvement cost 189*l*. The widening of a portion of Bailey Street is being effected as the properties purchased by the Council under their provisional order are disposed of. Numerous other street improvements of a more minor, though necessary character, have been carried out, the cost amounting in the aggregate to a very considerable sum.

Private Street Works.

"The Private Street Works Act, 1892," has been adopted. Three new streets or parts of streets have been made up by the Author, the specification providing for an 8-inch foundation of rough stone and 4 inches of Glyn metalling all well consolidated by the steam roller; cast-iron kerbing, channelling of blue bricks on edge with an outer row of granite setts, all bedded on 3 inches of cement concrete and grouted with cement; footways of tar-paving 3 inches thick, and cast-iron gullies. The cost of a 36-foot street made up as above, is about 2*l*. per yard run.

The above specification has been largely adopted of late for private streets, but in many, however, limestone kerbing and channelling is used with much more satisfactory results, although somewhat more costly.

Recreation Ground.

The Town Council in 1899 purchased a field 3¾ acres in extent, for recreative purposes for the sum of 900*l*., and the Local Government Board were asked to sanction the borrowing of 1083*l*. to cover the purchase and fencing, etc. The ground

has been enclosed where streets adjoin with a wrought iron unclimbable fence 5 feet high. Two pairs of gates, 12 feet and 9 feet opening, hung to cast-iron pillars, one wicket gate and two other openings protected by foot-way posts, have been provided. The ground originally being very uneven, a portion of this has been filled up and levelled, and filling up on another portion is still going on. It is also intended to put in hand the excavation of a large hump and the filling up of the hollow part, which, when completed, will render the ground much more suitable for playing purposes, and a foot-path will be formed at the top side running along the entire length of the ground.

Conclusion.

The whole of the new street work, public street improvements, new sewers, and water main extensions referred to as being carried out during the past 2½ years has been done administratively under the supervision of the Author.

The Author's office staff consists of two pupils, and all the plans, details, etc., for works carried out, or which are in hand, and others not mentioned have been executed by him with that assistance only, and he is pleased to be able to state his indebtedness to the Mayor, the Chairmen of Committees and the Town Clerk for their advice and assistance in the carrying out of his onerous and multifarious duties.

During the years 1899 and 1900 four Local Government Board inquiries on various matters have been held here.

The Author has endeavoured to make his paper as complete and instructive as possible, and trusts that he has not been too lengthy or tedious in the attempt.

DISCUSSION.

Mr. J. Price: It gives me very great pleasure to propose a hearty vote of thanks to Mr. Lacey for the very complete and detailed paper he has read. I think the paper is very well described in the last paragraph. With regard to the water supply, I should like to know the reason for the increase in the cost of construction of the impounding reservoir from 9341*l.* to 21,806*l.* There must be, presumably, some very good reason for

that enormous increase in the cost of the work. Then with regard to the hardness of the water: I presume, as the supply is obtained from a granite watershed, you get a pretty soft water. If the degree of hardness of the water be added to the paper it will increase its value. As to the cost of scraping the water mains, I take it that the cost of one-tenth of a penny per yard lineal is for each time and not the annual cost of scraping. The question of the bye-laws is touched upon in the paper. I consider it is quite as important that the Association of Municipal and County Engineers should have a say as to what the bye-laws should be as the Institute of British Architects. As regards the sewerage, I notice that the size of the main outfall sewer is 3 feet 9 inches by 2 feet 6 inches: that seems an excessively large dimension for the population. I presume to a large extent it is due either to the fact that it is a very flat gradient, or is intended to take a very large amount of storm or surface water, with no available storm overflow. Then I notice you have a very large discharge—something like 45 gallons per head per day, which is very excessive. I can quite understand the difficulty with the Local Government Board if your disposal works had to be calculated on six times the average flow, because that would represent 264,000 gallons a day, which no Local Authority of the size of Oswestry could be expected to cope with. As to refuse collection, Oswestry is very well ahead, but when you come to disposal, I think despite the cost of a refuse destructor, that you might adopt some better method than the tipping of the refuse in the vicinity of the town. I trust the Council will see their way to cremate it, even if they do not get the £ *s.* *d.* from the cremation in the shape of power. I notice that is the intention of the Council to purchase the electric light, and it would be a question whether they could not get some auxiliary power from the cremation of the refuse. With regard to street lighting, I would like to know the number of hours the lamps are lighted, as that has an important bearing on the cost per lamp. As to sewage disposal, the flow of the watercourse into which the effluent is discharged is a somewhat important matter in determining the character of the effluent. With regard to the bacteria beds, I would like to be informed as to the cost per acre. As to public street improvements, there is no public

money better spent, and I am quite sure all the Members will congratulate Oswestry on the endeavour to effect street improvements. Money may be put on one side for baths, etc., but street improvements are with us always.

Mr. A. T. Davis: I have much pleasure in seconding the vote of thanks so ably proposed by Mr. Price. The motto of the town Mr. Price represents is Forward, and that motto is quite as applicable to Oswestry as to Birmingham. I know no town in Shropshire whose policy is so go-ahead as the town we are now in. They are most energetic in everything they do, and I am sure the town is to be congratulated upon having such an energetic Borough Surveyor in Mr. Lacey. I notice that while from 1891 the population has increased by 1204, some 446 houses have been built. Therefore it looks as if the town has been over-built, unless there has been a good deal of pulling down of old houses. I know the tendency on the part of builders is to put up houses, and of tenants to remove from the old houses and go into new ones. With regard to the ventilation of the sewers, I would like to ask if the seven ventilating shafts are sufficient to properly ventilate the sewers, as I notice most of the surface ventilators are closed. I would also like to know the diameter of these shafts. With regard to the collection of house refuse, I can congratulate Oswestry on having adopted a system of collection, but I am somewhat doubtful as to whether they have gone as far as they might have done. I am open to correction, but I think the collection is from the streets and not from the houses. I think that Oswestry should go one better, and allow the roadmen to go to the backs of the houses and collect the refuse, and not force the people to put the unsightly stuff in the streets. I would also like to ask if the Welsbach incandescent street lighting is satisfactory, and who bears the cost of the mantles.

Mr. J. Lobley: I have much pleasure in supporting the vote of thanks to Mr. Lacey. The paper touches upon a great many subjects, but none of more interest than that of public street improvements. I think the Corporation of Oswestry are to be commended for dealing with this subject. As a rule it is a very difficult matter indeed to get the councils of small boroughs to give sufficient appreciation to the necessity for this work, particularly in towns where the streets are very narrow. The only point that strikes me is whether in a few

years they will not find they have limited the widening a little too much. I see they are widening several of the streets up to 30 feet, and one street to 36 feet, alongside the recreation ground. Now 30 feet is not very wide, although, of course, it is a great improvement on a width of 15 feet 6 inches. At the same time the experience I have had may be of some use to Members of the Association in this matter of street improvements. Thirty years ago I had the greatest difficulty in inducing my council to see the necessity of widening streets. We then widened a street from 15 feet 6 inches to 36 feet, and now we wish we had made it very much wider. In the case of several streets 30 feet wide the tramways have had to be abandoned because it was impossible without the frontagers' consent to take a tramway through a street of that width. I know the cost of these street improvements is a serious matter, but then you must bear in mind that the cost will not become smaller in the future. In cases where you have to purchase the land under compulsory powers the cost is very great indeed. I remember in the case of the main road between Hanley and Stoke, a distance of 1½ miles, I induced my council not to go to the expense of a Provisional Order for the purchase of land, but to prevent matters from getting worse by refusing to permit new buildings to be put up on the old street line. A member of my council said it would be folly to think of it; it would never be done in his time. I am happy to say that 95 per cent. of that road is now widened by adopting the policy of not allowing matters to get worse. If you are desirous of widening a road do not permit any new buildings to be put up, or any vacant land to be built upon up to the old street line. By following that rule I have induced my council to deal with miles of street improvements. It is now easier for me to get a street widened up to 55 feet than it was years ago to 36 feet, as the council and the public now see the necessity of it. I feel in a town like Oswestry in ten years' time they may regret having fixed the building line at 36 feet.

Mr. J. Parker: There is only one point in the paper to which I should like to refer—that is the question of refuse destructors. The Sanitary Committee are of opinion that the refuse can be turned to no useful purpose. From that view I entirely dissent. I think there is a great future before refuse destruction, apart from the first object of its destruction on

sanitary grounds, for each pound of refuse can be made to evaporate 1 lb. of water for power purposes. In connection with electric lighting or some other purpose I think Mr. Lacey will find it well to use that steam-raising power.

Mr. A. D. GREATOREX: I congratulate Oswestry upon the results of the bacteria system, results which are now pretty well an admitted fact. I should like to ask Mr. Lacey, as regards the capacity of the beds, whether he has had a meter fixed from the commencement of the work, or how he has obtained his data as to capacity. In my own case I find the capacity is reduced by about 30 per cent. I have had meters at works at West Bromwich and am still gauging the capacity of the beds. It is the one thing we require very definite imformation about in connection with the bacteria system, and I would advise every town to have meters fixed, and collect the information for the benefit of the Members of this Association. Judging from the cost of the beds at Oswestry they have been carried out remarkably cheaply, very much cheaper than we have been able to carry out our works. The Local Government Board will not sanction loans for bacteria beds unless they are built of bricks or concrete. My own scheme is now before the Local Government Board. They held a very exhaustive inquiry into the application, and the Inspector spent ten hours with me at the works, seeing the process from the beginning to end, and taking samples every five minutes of the crude sewage and from the coarse and fine beds. Copies of the samples were sent to our analyst, to Mr. Dibdin and to the Government chemist. One reason why the Local Government Board were so particular is that we have made very strong representations to the Board to have permission to discharge our effluent water direct into the stream without further land treatment. When you are dealing with 1½ million gallons a day, to pump that effluent on to land would cost 600*l.* a year. I am still hoping we shall obtain that sanction. I think ours is an exceptional case because we have no land upon which we can put our effluent without pumping, aud it is costly to have to pump it. I should like to know if there is any extra cost for the incandescent lamps for street lighting. (Mr. Lacey: No.) In West Bromwich the Corporation own the gas, but the gas committee charge us 10*s.* per lamp per annum extra for incandescent lights.

Mr. J. S. PICKERING: I wish to add my congratulations to

those of other Members to Mr. Lacey for this very admirable paper. With reference to bacteria beds, I quite endorse what Mr. Greatorex has said as to the necessity of measuring the effluent from the beds either by meter or some equally accurate means. A mere general statement that these beds do not decrease in capacity is not sufficient. I think it will be found in every case, without exception, that a gradual silting up is taking place, notwithstanding the opinion of many experts to the contrary. It may be very gradual but sooner or later I am of opinion that the resifting of the whole of the material will have to take place. I do not know that this is any very serious objection to the use of the bacteria system. In fact, though I recognise the difficulty may arise I am putting down beds to the extent of 14,000 square yards. But it does affect the question of material very considerably. It used to be thought that coke and ashes were the best materials for the beds. I think that idea is now exploded, and it seems to be recognised that any hard material will answer the purpose. My own opinion is that it will be difficult to find a better material than granite. I am using granite for the coarse, and probably for the fine beds. I think the advantage will be seen when we come to sift the material. In the case of coke it will be a difficult matter because there will be a great deal of disintegration. As to the efficiency of the bacteria system there cannot be the slightest doubt that it is proved beyond all question. Mr. Lacey incidentally remarks that he has made a series of analyses. I find Mr. Lacey has actually made those analyses himself. The duties of a borough surveyor are very varied, but we do not often find that he will take the trouble of studying the scientific analyses of sewage. Mr. Lacey has taken a great number of analyses, and has had the advantage of comparing the results from day to day. I think if some of us could follow his example it would be of very material assistance to us. The system of ascertaining the results as to albuminoid ammonia and oxygen absorbed is a comparatively easy one if you have a small laboratory, and the tests would be found useful for one's personal information. I should like to ask the cost of pumping with an electric motor. My own opinion is that the cost of pumping with electric motors is a heavy item as compared with other power, but as Mr. Lacey gives the actual duty of the pump the cost would be interesting. I should like also to know

whether any difficulty is experienced from the large open water reservoir. It is usual to have the service reservoir closed owing to the growth of vegetation which often takes place in open reservoirs. Dr. Lewis mentioned the difficulty of a turbid water supply, and asked for a remedy. I suppose there is no reason why it should not be filtered through sand. In my case we have a water very turbid, like the water in Oswestry, due not to peat but to iron, and I find sand filtration takes the whole of that out and leaves the water of a very bright appearance.

The PRESIDENT, in putting the vote of thanks to the meeting, said: The value of this paper is proved by the admirable discussion, and I think it very strong proof of the value of Mr. Lacey to his Corporation, and the good work that is being carried on by him.

Mr. W. LACEY, in replying to the discussion, said: I have to thank you most sincerely and heartily for the compliment you have paid to me. I may say that the preparation of the paper has given me a great deal of pleasure as well as of work, but the pleasure it has given me by far counterbalances the amount of work. I do claim to have the interests of the Association at heart. I have been a Member now for nine years, and I wish as much as anyone to see the Association prosper and be of as great a service as possible to Municipal Engineers. Anything I can possibly do to forward the interest of the Association will be done with the greatest possible pleasure. Mr. Price mentioned the difference in the cost of the construction of the impounding reservoir from the original contract. I can only assume the cause of that difference, as it was constructed before my time. The original contractor failed to complete the work, the remainder of which was re-tendered for and was to cost as much as the first contract. The Corporation then decided to carry out the remaining work without the aid of a contractor, under the supervision of the engineer, Mr. Henry Rofe. Probably the difficulties they had to contend with, coupled with the inconvenience of picking up another man's work, and also, I believe, legal matters, accounted for the difference. The hardness of the water is 3·5°, of which 3·3° is permanent. The cost of the scraping of the main is one-tenth of a penny per square yard lineal each time that the main is scraped. We go through the main twice on each occasion. The size of the outfall sewer is no doubt due, partly, to the

inclination of the sewer, and there is a large amount of storm surface water brought down from the district. We get heavy rainfalls here; we have had one inch in half an hour, and that wants considerable capacity to be able to deal with it. The amount of sewage dealt with is very excessive, and that is due to several causes. We have a couple of watercourses from which the tanneries obtain their supply, and they discharge a large quantity into the sewers. There are also some sewers which admit spring water in places, and if we could eliminate that from the sewers we should be in a better position. I cannot give you off-hand the number of hours the lamps are lighted. As to the stream into which we discharge the sewage effluent, it is very small indeed. In fact where our immediate discharge is there is no other flow at all. The effluent flows some yards, when it joins some water from the town, and then two miles further on joins the river Morda. The cost of the bacteria beds comes out at 3*s.* 6*d.* per square yard. Mr. Davis has referred to the number of houses built in relation to the increase of population. It would appear that there is a good deal of truth in what he said that the town has overbuilt itself and the old property is left in the lurch. The size of the ventilating shafts on the sewers is 6 inches in diameter. We get very few complaints of smells from sewer ventilators in the streets, which is chiefly attributable to the small number of manholes we have on our system. They were not very lavish in the construction of manholes in 1866. As to street lighting, there is no doubt the Welsbach mantle is an improvement upon the ordinary gas lighting. The great thing is to prevent vibration so far as the life of the mantles is concerned. The cost of the mantles is no insignificant item though we are not charged extra for it. Mr. Lobley referred to the width of the streets which have been widened for public improvements. Under the bye-laws all new streets must be 36 feet wide. The particular improvement carried out at 30 feet was because the owner would not sell more land than sufficient to make a 30-foot road. There is no doubt 30 feet is not so wide as a street ought to be in the interests of the town and of the public health. I was glad to hear Mr. Parker's advocacy of refuse destruction. I am not opposed to it by any means—in fact, I would like to see the Council build a destructor, and perhaps this discussion will induce them to reconsider their decision. It was suggested when we had an

inquiry that the power obtained from the destructor might be utilised for electric lighting, but the station is in the centre of the town, and there would be little space for the erection of a destructor even if it were desirable, and the suggested site is too far away from the town to be useful for electrical purposes. Mr. Greatorex has referred to the gauging of the flow from the bacteria beds. We have gauged it by meter almost from the commencement of working the beds; and we test the time the whole of the beds take to fill, and then calculate the quantity. We have not a meter from the primary to the secondary beds, but we can judge the capacity in the secondary beds from the time they take to fill from the primary beds. I am inclined to be at one with Mr. Pickering as to the material forming the beds. With cinders there is a tendency to disintegrate and become finer. If we could have had a coarser stuff for the primary beds it would have been better. It is all right now, but what it will be in ten or twenty years' time I cannot say. I have somewhere, roughly, the cost of raising the sewage from the tank for the small district below the gravitating sewers. It is only an approximate one, but as it also includes the getting of the sludge from the tank I can hardly give it as the cost of pumping alone. It works out at close upon 1s. per 1000 gallons per 100 feet of lift, which is an enormous sum. We find the work entails a great deal of wear on the cylinders in the drum. As to the open service reservoirs, I do not know that we have had any objection. With a water of this class it is rather beneficial for it to be acted upon by the light. We do get a good deal of vegetation, but we clean it out and limewash the reservoirs every year. What we propose to do is to re-pitch the banks. Of course, if a reservoir is closed the water is likely to be cooler.

The Members attending the Meeting were entertained to luncheon at the Wynnstay Arms Hotel by the Mayor and Corporation of Oswestry. The Mayor presided and the Town Clerk occupied the vice-chair.

The visits included an inspection of the market extensions, the filter beds and reservoirs of the Liverpool Corporation waterworks under the guidance of Mr. W. Davies, resident engineer, and the sewage disposal works, with the bacteria beds, which are fully described in Mr. Lacey's paper.

DISTRICT MEETING AT CHICHESTER

June 1, 1901.

Held at the Council House, Chichester.

CHARLES H. LOWE, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Members were received by the Mayor (Mr. R. Crombie Miller) who expressed his pleasure in welcoming the Members of the Association, remarking that their valuable work was of the greatest practical utility.

The President offered the Mayor and Corporation the best thanks of the Meeting for their kind reception, and for the use of the Council Chamber for the Meeting.

Mr. Thomas (the Hon. District Secretary), reported that Lieut. Stallard acknowledged with many thanks the Council's letter of good wishes.

The following paper was read and discussed.

MUNICIPAL ENGINEERING WORKS IN CHICHESTER.

BY JAMES SAUNDERS, A.R.I.B.A., CITY SURVEYOR.

HISTORICAL.

CHICHESTER is an ancient Roman city, and derives its name from "Cissan-ceaster," the "Fortress of Cissa," who rebuilt it about the end of the fifth century.

The city was besieged by Sir William Waller during the Civil Wars, and eventually capitulated.

Several charters have from time to time been granted to the city, the earliest dating from the reign of King Stephen. James II. granted a charter, under which the government of the city was vested in a mayor and corporation. The boundaries of the city were extended in the year 1893, and again in 1895.

Physical Characteristics.

The city is built on a gravel basin 20 to 30 feet thick, overlaying the "Reading" clay beds, under which lies the chalk. The gravel is very porous and flinty, and has veins which allow the subsoil water to flow underground with perceptible currents.

In the winter and early spring time the subsoil water rises considerably, owing to the heavy rainfalls on the South Downs, the chalk of which these Downs are composed acting as a gathering ground and filter of great area. The river Lavant runs on the south of the city, rising in the Downs. It is an intermittent stream, generally commencing to flow about February, and ceasing towards the end of June.

City Walls.

These walls nearly encircle the city, and are about a mile and a half long, only about half of this length being accessible to the public. They are of Roman origin, and were extensively rebuilt in the reigns of Edward III., Richard II., and Henry VI.

There was originally a gate at the end of each of the four main streets, and sixteen towers. These have been removed, the last gate being pulled down in 1783. The walls consist of a stone rubble core faced with flint work, and are kept in repair by the Corporation.

The Market Cross.

At the intersection of the four main streets stands the cross, built by Bishop Storey about the year 1500. It was repaired in 1562, 1574, and in 1724 completely restored by the second Duke of Richmond. In 1853 it was again proposed to restore it, and from that time up to the present the subject has continually been under discussion; several reports have been

made and considered, but public opinion has been divided between repairing to prevent decay or restoration to its original beauty. A committee of the Council are now again considering its state, and will shortly report on the matter.

Dell Quay.

The Corporation own a quay situated on the Chichester harbour, and vessels of 350 tons burden can be berthed. There is a very good trade in corn, coal, etc., and about 100*l.* is yearly handed over from the dues in relief of the borough rate.

At the request of the Council, the Author has prepared a scheme for enlarging the quay, dredging the channel, erecting new stores, and other works, and it is now under consideration.

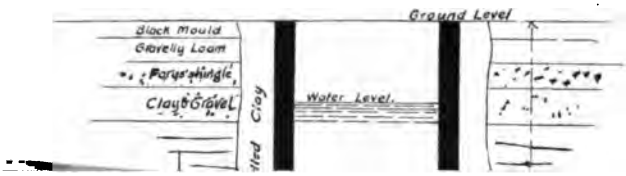
Canal.

The Corporation also own a navigable canal, joining the city with the Chichester harbour; it is about 4¼ miles long, has two locks, and an extensive basin with commodious wharfs and store-yards on the southern side of the city.

Isolation Hospital.

In 1890 the Corporation erected an isolation hospital at a cost of 2230*l.*, on lines suggested by the Local Government Board. There are two large wards, each 24 feet by 18 feet by 12 feet high, and two small wards, each 18 feet by 12 feet by 12 feet high, with two kitchens, caretaker's house, laundry, mortuary, disinfecting rooms, etc. Considerable discussion has taken place from time to time as to the advisability of enclosing the corridors, many complaints having been made by the doctors and nurses. The fact however remains that the nursing at the hospital has been a complete success, very few deaths having occurred among the total number of cases admitted to the hospital. Since 1890 to the present time, 384 cases of various infectious diseases, viz. enteric fever, scarlet fever, diphtheria, erysipelas and small pox, have been admitted, and of these only 11 persons died, the death rate being at the rate of 28·6 per 1000.

PLATE I.



Ground Level
Black Mould
Gravelly Loam
Farys shingle
Clay & Gravel
Clay
Water Level

Drainage of the City.

Previously to 1894 the city was without any drainage system, the general method of disposing of the sewage being by turning it into soaking cesspools. Some of these the Author has examined, and one he measured was 14 feet by 12 feet by 9 feet deep, directly under one of the living rooms of the house, and when opened was nearly full of solid matter. Owing to several outbreaks of enteric fever and the general insanitary condition of the town, a strong feeling was manifested by some of the leading inhabitants to drain the city. There was much hostility to this proposal, and a war of "Drainers" *versus* "Anti-Drainers" was for some years bitterly waged. Several engineers were called in to advise the Corporation, and schemes for the drainage of the city were prepared by Mr. Jones, of Ealing, Sir Frederick Bramwell, and ultimately by Baldwin Latham, M. Inst. C.E., whose scheme was adopted and carried out.

In the "drainage campaign" one of the medical practitioners in the city strongly advocated in lieu of drainage, a scheme to sink cesspools opposite each house in the centre of the streets, and have the same emptied periodically by night turns.

Sewers.

The sewers in the city, 19 miles in length, were designed to take sewage only, the surface-water passing through old drains into the Lavant course. They are constructed of 9-inch, 12-inch, 15-inch and 18-inch stoneware pipes, some being laid with Hassall's patent joints, others with tarred gaskin and cement joints. The falls are sufficient to give a velocity of 3 feet per second. At the head of each sewer is an automatic syphonic flushing tank having a capacity of about 500 gallons. In addition to the automatic flushing, many of the manholes are fitted with movable wooden shutters for flushing; the Author prefers this method to the automatic syphons. The sewers are ventilated with 7-inch columns, about 30 feet high and about 300 yards apart. Every house is disconnected from the main sewers by a special form of interceptor trap, having an air inlet in the pavement opposite, the far end of the drain being carried up as a ventilating shaft. A considerable number of complaints respecting these air inlets have been received,

and occasionally during particular atmospheric conditions, the air inlets act as outlets, and the emanations from the house drains offend the pedestrians in the streets. In all fairness, it should however be stated, that every case of nuisance arising from the gratings has invariably been found to be caused by the house drains being improperly flushed. The main outfall sewer is partly a 21-inch brick sewer, built in cement, and partly a cast-iron pipe syphon, 620 yards long, consisting of two 15-inch pipes. Means are provided for flushing each of these pipes out, which is done twice a week, and there has not been the slightest trouble in keeping the pipes free from deposit.

Leaky Sewers.

Owing to the great variation in the height of the subsoil water, which in some parts of the city has a rise from the minimum of 15 feet, many of the sewers are for about three months of the year under water, and in some cases there is a head of 6 or 7 feet on the top of the pipes.

Some of the sewers were laid in water, the consequence being that there is occasionally a considerable leakage of subsoil-water into the sewers. Many of the most serious leaks have been stopped, the greatest difficulty met with in doing so being in finding out the exact place of the leaks. The means adopted were to float lights down the sewer, and measure the distance to the leaks; this has been successfully done, and in nearly every case where trenches have been sunk the sewers are found to be in good condition, the leakage coming from improperly stopped junctions or defective house connections.

Outfall Works.

The outfall works are about a mile and a half west of the city, and occupy about 10 acres of ground.

The sewage first enters a salmon ladder running the whole length of the buildings. In its course lime-water at the rate of 3 grains of lime per gallon of sewage is added first, to render the sewage slightly alkaline, and further down the salmon ladder alumina ferric at the rate of 3 grains per gallon is also added, the whole passing then through a rough screen into the precipitation tanks, of which there are three, each measuring 55 feet 6 inches by 20 feet by 5 feet averaged depth. Two of

these are worked each day while one is being cleaned, the sludge being pumped up with chain pumps, and lime added in a mixing pit at the rate of 1 cwt. to 100 gallons of sludge. This is afterwards forced with direct-acting pumps into sludge presses.

The averaged dry weather flow of sewage is about 300,000 gallons per day, the amount of pressed cake being about 24 tons per week, and about half a ton of rough screenings per day is taken off the gratings. The tank effluent is afterwards passed over about 6 acres of land, laid out on the ridge and furrow system, and retained in a tidal storage tank, holding about 320,000 gallons, until the tide commences to ebb, when it is discharged. The ground has been cultivated, and last year a very good crop of mangolds, cabbages, broccoli, white carrots, etc., was grown, the value realising about 80*l.*, and this about covered the working expenses.

The effluent passes into the Chichester harbour through a 21-inch pipe by means of a penstock valve and tidal flap. The harbour is of great extent, and is subject to a tidal change of about 24,000,000,000 gallons per day.

The cost of the sewage works was as follows:—

	£
Sewers, manholes, &c.	19,685
House connections	4,922
Ventilation	1,229
Flushing tanks	910
Buildings	1,446
Precipitation tanks	911
Sludge tanks	254
Machinery	1,836
Laying out land	1,120
Tidal storage tank	457
Roads and fences	496
House and cottages	1,200
Purchase of land	2,250
Wayleaves	800
Preliminary expenses: Local Government Board inquiries, engineer's fees, resident engineer and clerk of works salaries, etc.	4,718
Total cost	£42,234

The annual cost of upkeep is as follows:—

	£
Interest and repayments of capital	1,109
Labour, chemicals, repairs, coal, lime, farming, etc., at outfall works	1,040*
Flushing, labour in cleansing and repairs to sewers	270

* This is at the rate of about 7*l.* per million gallons of sewage treated.

Water Supply.

From the relics of old elm pipes which are met with occasionally when making excavations in the streets, it is evident that in very early times the city had a recognised water supply.

Some time in the seventeenth century a spring on the northern side of the city was tapped, and a "conduit" run into the town; this consisted of a 2-inch lead pipe, and it supplied some of the houses and a public fountain in South Street until recent years; the pipe is now broken, and the supply has practically ceased.

Apart from this, the main source of supply before the present waterworks were established, was by shallow wells. The Author has a very vivid remembrance of visiting a house invaded with enteric fever, the site measuring 14 yards by 4 yards, entirely covered with buildings, and on this was a shallow well furnishing the water supply, and a soaking cesspool disposing of the sewage, and this was, until recent years, the usual sanitary condition of most of the premises in the city.

Mainly owing to the efforts made by the present deputy-mayor, Mr. Alderman Smith, the Chichester Waterworks Company was formed in 1873. The works were designed by William Shelford, Esq., and a pumping-station and well sunk about one and a half miles west of the city.

In 1898 the Corporation purchased the works for 55,000*l.*; at this time a new well was in progress, and new pumping plant on order, and this was started in June 1898.

About six miles of water mains have been laid during the last three years, which makes a total of about twenty-one miles of mains.

The pumping-main passes through the city on its way to the reservoirs, and connections are made to it *en route*.

This is a most unsatisfactory arrangement, and numerous complaints are received respecting noises in the pipes, and ball-valves and bib-taps are constantly under repair.

In two places the Author erected air-vessels on the mains with great advantage. These consist of a 10-inch flanged pipe 9 feet long, connected to the main with a 3-inch branch. They are fitted with a gauge-glass and are self-charging.

In consequence of several years of drought, and the exten-

sive additions carried out to the mains, the pumping-plant was found to be incapable of supplying the city with sufficient water.

The Author advised that an additional pumping-engine and boiler capable of supplying a million gallons per day should be erected, and that one of the old engines should be taken out and the new engine inserted in its place.

This necessitated the old and new wells being connected, as the old well is only capable of supplying about 12,000 gallons of water per hour, the new well yielding more than ten times this quantity.

Syphon.

The wells were connected by means of a 12-inch syphon, constructed of flanged cast-iron pipes, jointed with gutta-percha; it is connected at will to the air-pumps on the engine, and so kept charged, and opening the valve for a few minutes once a day is the only attention it requires. A "Korting's" vacuum-ejector is also fixed for charging after it has been disused for some time, and this answers the purpose admirably.

The water-level in the wells is kept nearly the same, even when pumping at the maximum rate.

New Pumping Plant.

A specification was prepared and tenders advertised for, and eventually Messrs. Jas. Simpson & Co.'s offer was accepted for a six cylinder horizontal tandem, triple expansion, surface condensing engine, with double-acting ram pumps.

The two high-pressure steam cylinders are each 8 inches diameter, the intermediate cylinders 12 inches diameter, the low-pressure cylinders being 20 inches, the double-acting pump plungers being 8¾ inches diameter.

The stroke is 15 inches, and all the cylinders are cast of ample thickness so that they can be rebored, and they are all steam jacketed throughout, and the steam in returning is used to work the donkey feed pump. The whole of the valves are of gun-metal, and the pump rods and rams of delta-metal. The cylinders are coated with non-conducting composition and finished with Russian steel.

A cylinder lubricator so constructed as to force a regulated quantity of oil per stroke is used, and is found to be a great improvement on the ordinary sight-feed lubricators.

The steam after passing through the cylinders enters an oil separator and thence on to the condenser, which is fitted with solid drawn gun-metal tubes.

BOILER.

The boiler is 20 feet long, 7 feet diameter, and of the Lancashire type, each flue being 33 inches in diameter. The shell plates are $\frac{5}{8}$ inch thick, and all holes are drilled and the riveting done by hydraulic pressure. The flue plates are $\frac{15}{32}$ inch thick. The working pressure is 120 lbs. per square inch, but the boiler was specified for a working pressure of 140 lbs. per square inch, and was tested up to 250 lbs. per square inch and found to be drop dry.

The steam is superheated, and in ordinary working it is found that from 120° to 130° F. of superheat is added.

A feed-water heater is used, and this heats the water to nearly boiling point and deposits the solid matters, so that fairly soft water is used in the boilers.

Two six-hours coal and steam trials of the engines were made, with results shown in the table.

The conditions under which the trials were carried out were as follows:—

The delivery-head was read from an 8-inch Bourdon gauge placed on the delivery main in the engine house; this was tested after the trials. The level of the water in the well was recorded, and the level of the Bourdon gauge from the floor line, added to the other reading, constituted the total head pumped against. These observations were recorded every 15 minutes.

The strokes were recorded by a "Harding's" counter attached to the engine, and were read at 15-minute intervals.

The boiler pressure, steam pressure in engine house and vacuum gauges were read every 15 minutes.

The steam-cylinders were indicated every 30 minutes—the high-pressure with the "Simplex," and the intermediate and low-pressure with "Richards'" indicators.

	Low Head.	High Head.
Date of trial	March 20th, 1901	March 20th, 1901
Time of starting	10.15 A.M.	4.45 P.M.
Time of finishing	4.15 P.M.	10·45 P.M.
Duration	6 hours	6 hours
Total number of double strokes.. ..	11,658	18,567
Averaged strokes per minute	32·38	51·57
Length of stroke	15 inches	15 inches
Gallons pumped per hour	27,065	43,106
Total head in feet	224	330
Steam pressure at boiler	120 lbs. sq. in.	117·5 lbs. sq. in.
Steam pressure in engine-house ..	117 lbs. sq. in.	108 lbs. sq. in.
Vacuum, in inches of mercury	27·1	26·5
Barometer	29·4	29·39
Temperature of steam before passing through superheater	340·1° Fah.	339° Fah.
Temperature of steam after	411·2° Fah.	474·6° Fah.
Averaged amount of superheat	71·1° Fah.	135·6° Fah.
Temperature of air-pump overflow ..	68° Fah.	73° Fah.
Temperature of feed water	60° Fah.	59° Fah.
Temperature of feed water after heater	110° Fah.	108° Fah.
Total feed water used	3516·6 lbs.	8200 lbs.
Feed water used per hour	586·1 lbs.	1366·6 lbs.
Jacket water (included in feed water) per hour	103·5 lbs.	92 lbs.
Total coal used	376 lbs.	840 lbs.
Coal used per hour	62·57 lbs.	140 lbs.
Clinkers and ashes	25 lbs.	53 lbs.
Pump horse-power	30·61	71·84
Indicated horse-power	33·23	77·771
Mechanical efficiency	92·07 %	92·37 %
Feed water per pump horse-power per hour	19·14 lbs.	19·02 lbs.
Coal per pump horse-power per hour	2·044 lbs.	1·94 lbs.

The quantity of water pumped was determined by measuring the length of stroke, and using same to arrive at the displacement of the pump-plungers, which were multiplied by the number of strokes recorded by the counter.

The coal used was "Nixon's" steam navigation from the ordinary stock, and was broken into lumps of suitable size and weighed out in half-hundredweights as required, there never

being more than a half-hundredweight on the boiler-house floor at one time. The amount of coal in the boiler furnaces, as judged by the level of the fires, was equal at the beginning and end of trials.

The jacket water was measured out into large oil drums by means of flexible hose connecting from the exhaust to the jackets.

All the temperatures were recorded every 15 minutes by standard thermometers tested at Kew Observatory.

The cost of the plant was as follows:—

	£
Pumping engine, boiler, etc.	3,500
Builder's work	370
Connecting to mains, syphon, and other incidental work	225
Total	£4,095

Reservoirs.

The reservoirs are on an eminence on the northern side of the city, and there are two reservoirs, each holding about 100,000 gallons.

The lower reservoir is constructed of brickwork rendered inside with cement; the roof is brick arched on substantial brick piers.

The upper reservoir is raised 40 feet above the ground level on brickwork arcading; it is supported on rolled-iron girders. The tank is constructed of cast iron, and is 85 feet 6 inches by 21 feet 6 inches by 9 feet 6 inches deep. It was designed by W. Shelford, Esq., and built by Messrs Beck & Co.

There is also a small tank which is used when the large high-level tank is being cleansed.

The method of working the reservoirs which the Author has instituted, is to pump continuously into the high-level reservoir, and when the engines are stopped during a few hours of the night, to draw off 5 feet of water from the upper reservoir for use in the city, leaving the lower 5 feet to supply a small high-level area when the water in the high-level tank drops to 5 feet; the lower reservoir then, by means of a reflex-valve, automatically connects to the water mains.

Waste Prevention.

A 5-inch Deacon's water-waste meter has been recently erected, and its use has resulted in a great diminution in the consumption of the water.

A water-inspector has also been appointed, and is making a house to house inspection of the city.

Conditions of Mains.

In carrying out work in various parts of the city, the Author has always particularly noticed that the mains are in splendid condition, some of them have been in nearly thirty years, and when broken down upon are as sound as when put in; there is never any deposit on the inside of the pipes, and in a great many cases the solution on the exterior of the pipes can be plainly seen.

Technical School.

Provision was made in the technical school for an art room, 61 feet by 23 feet, lighted from the north; lecture hall, 47 feet by 23 feet; carving and modelling room, 25 feet by 23 feet; committee room, cloak rooms, and lavatory accommodation. The end of the lecture hall is prepared and painted a dead white, and used as a lantern screen.

The plumbers' and carpenters' shop is on the ground floor, and is 33 feet by 15 feet. This has been found to be inadequate for the number of students attending.

The whole of the buildings are heated with hot water with 2-inch circulating pipes, and radiators in each room.

The Council granted the old butter market as a site, and gave the Technical Instruction Committee permission to build on the upper floor. The old front, erected in the seventeenth century, was retained, and the upper story, which was executed in Chilmark stone, was built to correspond.

	£
The cost of building was	2,158
Furniture, etc.	145
Total	£2,303

The fountain was a gift to the city by Mr. Alderman Ballard, and was erected in commemoration of the Diamond Jubilee.

Cattle Market.

The cattle market, which is one of the largest in the south of England, was built in 1877, the engineers being Messrs. G. and T. Hawksley; the fittings are all of good sound construction, have stood the test of time, and are very suitable for their purpose.

Electric Lighting.

The Council procured a provisional order for supplying electrical energy. The Author, in 1899, was instructed to prepare a scheme, and he proposed to make a combined power station for the whole of the energy-consuming undertakings owned by the Corporation, and by this means obtained a load line which was practically without a peak, the surplus power in the daytime being used at the sewage and waterworks.

It was proposed to light the main streets with arc lamps, and the whole of the bye-streets with incandescent lamps.

A destructor was to be erected for dealing with the town's refuse, and it was anticipated that the steam obtained from the destructor could be used to advantage in consequence of there always being a demand for power.

Owing to the war in South Africa, and the unfortunate reverses our army was then experiencing, and the disturbed state of the money market, the scheme was rejected by a few votes. The matter is now again under consideration by the Corporation.

DISCUSSION.

Mr. T. H. Yabbicom: I have pleasure in moving a vote of thanks to Mr. Saunders for the interesting paper he has read to the Meeting, and personally I thank him very much for giving me an opportunity of coming to this ancient and interesting city. I have never had an opportunity of coming here before, and when I heard the Association was going to hold a meeting here I immediately decided to attend. The history of the city dates back to Roman times, and it has interesting literary traditions. One of the first things I did on visiting the Cathedral this

morning was to ask for the memorial to Williams Collins, who added a brilliant light to the literature of England. We feel grateful to this city not only for reverencing the past but for living up to the necessities of the present, and I think the city of Chichester is to be congratulated that it has a Corporation so energetic and so appreciative of the necessities of modern life as to carry out all the important and useful works which Mr. Saunders has so ably described. I do not propose to enter into the paper at very great length, because the time is short, but there is one point I made a note of and wanted to ask Mr. Saunders about, that is the Isolation Hospital. Mr. Saunders says there are two large wards, each 24 feet by 18 feet by 12 feet high, and two small wards. (Mr. Saunders: That is the observation ward.) Does the width of 18 feet comply with the Local Government Board requirements? (Mr. Saunders: Yes.) I am interested because I have built and am going to extend an isolation hospital, so the information is extremely valuable. Working on this principle I think you have got a hospital built on very economical lines.

Mr. F. J. C. May: I rise with a very great deal of pleasure to second the vote of thanks to Mr. Saunders. We all know from our own experience how very difficult it is to find time to devote to the preparation of the papers which are so necessary for the information of Members, and therefore when our professional brethren come forward as Mr. Saunders has done to prepare so excellent a paper, we feel that our thanks are very much due and that we should be wanting in our duty if we did not acknowledge it. There is very little in the paper to criticise, as the works are so admirably explained that they do not lay themselves open to criticism. The paper is very clearly written and all the information given in such an admirable manner that I am afraid it will provoke but very little discussion.

Mr. A. J. Catt: I should like to endorse in a word or two all that has been said with regard to this paper. It is certainly a very interesting one, and one which conveys to all of us a large amount of information, and I, with all who are here, thank Mr. Saunders for the very able way in which he has prepared it. Having heard all that the Mayor has had to say with regard to this old and interesting city, it seems almost like sacrilege to go into mere everyday municipal matters too much, because we do not often have the opportunity of visiting so ancient a

city as Chichester. I noticed when Mr. Saunders was reading that interesting portion of his paper about the city walls he said, "There was originally a gate at the end of each of the four main streets, and sixteen towers. These have been removed, the last gate being pulled down in 1783." I was wondering when Mr. Saunders was speaking why the gateways were pulled down and the towers demolished, and whether there is any record of it in the archives of the city. I have in my mind the case of a very ancient town in Kent where such gateways formerly existed but which were demolished by the then governing body, chiefly, it is alleged, to obtain material for making their roads. I feel sure the ruling body of Chichester must have had a better reason for demolishing their ancient masonry.

Councillor Moore: The old city gateways could not possibly have been pulled down to widen roadways or to give more air, because when you are driving round this afternoon to Fishbourne you will find the jambs of the gateway still remaining.

Mr. R. J. Thomas: I should like to endorse the vote of thanks to Mr. Saunders, and, as I am interested in road-making, I may congratulate him on the state of the roads. I was very pleased with their condition and the smoothness of their surface. I must also congratulate the citizens of Chichester upon their famous old cross, which I hope they will restore. It is in need of repair and certainly deserves attention. It is a charming piece of work and should I think be so restored as to prevent further deterioration. I also had an agreeable visit to the interesting Cathedral and was much struck by the curious weather-tiling pattern of the enrichments beneath the clerestory. I have not seen that particular kind of embellishment before.

Mr. Saunders: There is similar work at Southwell Cathedral in Nottinghamshire.

The President: Without in any way trenching upon the question referred to by Mr. Saunders, I may safely say that enormous strides must have been made in Chichester since 1894, and we may safely conclude that the city has not been behindhand in its drainage works. The city is also to be congratulated on its preservation of canals. Canals form a very important highway for traffic which the public do not seem inclined to sufficiently regard. Mr. Saunders is doing a very great work in improving and strengthening canal carriage.

Canal transit is cheap although it is slow, but there is much that can be carried by this method of transit where time is not of paramount importance.

Mr. SAUNDERS, in reply, said: I beg to thank you very much for the kind way in which you have passed the vote of thanks. There are but few questions to answer. As far as the ancient gateways are concerned, I believe they were pulled down because they were an expense to the city. The citizens in those days liked to spend their money in riotous living. You will find in the old Corporation minute-books entries like this: "The Council made merry"; and this was about the time the gateways were pulled down. On the coronation of Queen Anne they made the conduit pipes which supplied the town with water run with wine. I may say respecting the cross that a committee is discussing the matter, and their idea is, not to restore it to its original beauty, but to repair it so that we can hand it down to the coming generation in almost the state it is at present.

The Members of the Association had luncheon together in the Assembly Room, Mr. C. H. Lowe, President, occupying the chair. The afternoon was devoted to visits to the technical school, the cattle market, the sewage outfall works, about 1½ *miles to the west of the city, and the waterworks pumping station. On returning to Chichester visits were made to the Priory Park, the Guildhall, St. Mary's Hospital, and the Cathedral.*

[COPY]

CHEMICAL AND BACTERIOLOGICAL LABORATORIES,
111 TEMPLE CHAMBERS, LONDON, E.C.

REPORT ON THE WATER FROM CHICHESTER CORPORATION WATERWORKS.

Sample taken November 21, 1900.

The chemical analysis shows that it is a typical chalk water of the highest quality. It is only moderately hard, and is of the greatest organic purity.

The Bacteriological examination is equally satisfactory, no organisms indicative of contamination being discoverable.

A purer or more satisfactory water it would be difficult to find.

(Signed) JOHN C. THRESH.

[COPY]

Data.

Respecting a sample of water from the city of Chichester waterworks.

Labelled :—Taken from standpipe in South Street supplied from the Chichester Corporation water mains at 3.30 P.M., November 21, 1900, by H. C. Wareham, Sanitary Inspector.

Physical Examination.

Turbidity :—Perfectly clear and bright. No deposit.

Colour :—Faintly blue. Odour, none.

Chemical Examination.

Determinations.	Results in	
	Grains per gallon.	Parts per 100,000.
Total solid matter dried at 120·6°	21·0	30·5
Chlorine	1·4	2·05
Equivalent to Chlorides 160 per cent. Cl	2·3	3·4
Nitric Nitrogen	·32	·45
Equivalent to Nitrates 17 per cent.	1·9	2·7
Nitrates	Nil	Nil
Hardness permanent, 2·5; temporary, 13°; total	15·5	21·5
Lead, copper, zinc, iron	Nil	Nil
Free ammonia	Nil	Nil
Organic	0·0007	0·001
Oxygen absorbed at 80° in four hours	0·0021	0·030

Vide Report enclosed.

(Signed) JOHN C. THRESH.

[COPY]

Saline Constituents of Chichester Water.

Each gallon of water contains :—

		Grains.
Carbonate of calcium		14·7
Sulphate "		1·0
Chloride "		1·85
"	magnesium	·3
Nitrate of potassium and sodium		2·2
Silicate " "		·95

(Signed) JOHN C. THRESH.

[COPY]

Bacteriological Examination of Chichester Water.

This examination was made for the purpose of ascertaining if the water contained any slight trace of a manurial or sewage matter, since the tests are more delicate than the chemical ones. Search was first made for the *bacillus enterides sporogenes*, using the residue from the bacterial filtration of a considerable quantity of the water. The results were negative.

(Signed) JOHN C. THRESH.

ANNUAL MEETING AT LEICESTER.

June 27, 28, and 29, 1901.

THE PRESIDENT'S ADDRESS.

By E. GEORGE MAWBEY, M. Inst. C.E.

In very gratefully receiving at your hands the highest honour you can confer upon me, I fully appreciate and value this proof of the esteem and confidence of the Council and the Members generally, in unanimously electing me your President.

I naturally feel proud of this compliment to the town and myself, and I shall earnestly endeavour to do all in my power for the advancement of knowledge and practice in the many branches of Municipal Engineering and the multifarious duties devolving upon us for the health, comfort and well-being of our people, and also for the prestige and still further progress of the Association and the benefit of our Members; and in this I know I shall have your loyal support and the assistance of all your representatives in office.

After twenty years of membership and being installed your President at the first Annual Meeting of the new reign and of the twentieth century, I might have given you an exhaustive retrospect of the achievements and enormous strides in sanitary science, and the important part taken in them by our profession and Members during the great and glorious reign of our much-beloved late Empress-Queen Victoria (whose loss touched our hearts more deeply than can ever be expressed), but those subjects have been so ably dealt with in admirable addresses by one or other of my eminent predecessors that I propose to refer to them only briefly in taking up some of the most

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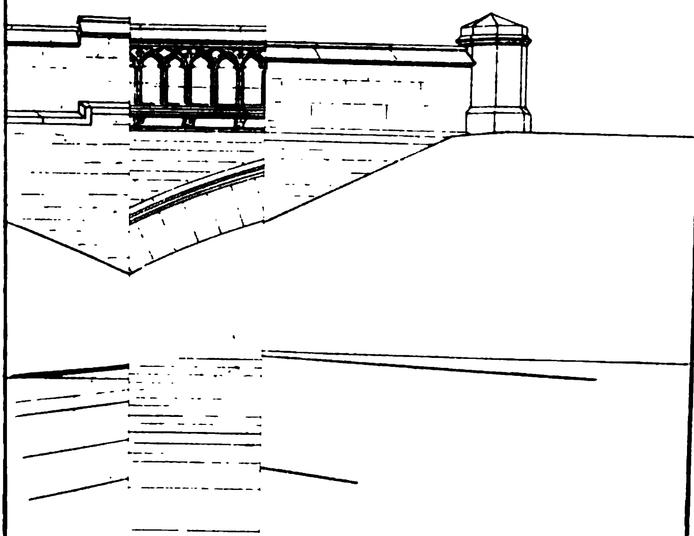


EY. M. INST. C.E.

GINEER & SURVEYOR.

CESTER.

E & Cº LTº 4 & 5 EAST HARDING STREET, FETTER LANE, E.C.

important questions of the present day affecting Municipal Engineers.

Vast and various as have been the enterprise, research, invention and achievement throughout the British Empire during the Victorian Era, the reign of our illustrious Sovereign King Edward the Seventh bids fair to make a record of unparalleled advancement. This is, in many ways, a time of great promise, and from what has already transpired we well know that His Majesty's most powerful efforts will be exerted in the encouragement and development of any good work or movement which will tend to promote and maintain the health and happiness of his people, as well as the peace and prosperity of our great Empire.

It is now fourteen years since our highly esteemed confrère and friend—and my predecessor—the late Mr. Joseph Gordon, was installed your President in this room, and twelve years on the 9th of November next since he was so suddenly taken from us, at the very zenith of his power, so soon after he was elected the Chief Engineer to the London County Council, and we have recently sustained another serious loss to our profession by the death of our very able and delightful confrère, Mr. W. Santo Crimp, in addition to others much missed—sad events which are not to be erased from our memories.

In our volumes recording the successful meetings held here in 1884 and 1887, the works of Leicester are duly described, and at the Autumnal Meeting in 1893 I completed the record of Mr. Gordon's splendid work. Therefore, in connection with the subjects of general and univeral interest upon which I wish to speak, I shall, in referring to Leicester works as practical examples, deal more particularly with what has been done here during the twelve years I have had the honour of being the Borough Engineer and Surveyor.

Few, if any, towns have shown more enterprise and public spirit, or have made greater progress in recent years.

The population twelve years ago—in 1889—was 138,000. In 1891, when our Borough Extension Scheme was promoted and won, it was 174,624. At this 1901 Census it has risen to 211,574; an increase of 21·16 per cent. in the decade.

The rateable value in 1889 was 522,309*l.*; in 1891, after the extension, 649,583*l.*; and it is now 841,301*l.*, an increase of 29·51 in the decade.

In the twelve years 41¼ miles of new streets have been made and sewered on the duplicate system, bringing the total length of streets and roads up to 178 miles, against 76 miles before the extension of the borough.

Plans have been approved since 1889 for 15,535 dwelling houses, 167 warehouses, 179 factories, 313 workshops, 314 special buildings, 10,968 miscellaneous alterations and additions, new drains, etc., and for 386 new streets, the whole covering over 500 acres of additional built area and involving an expenditure of, very roughly speaking, about 7,000,000*l*., which speaks with a peculiar eloquence of the progressive commercial prosperity of the town.

During this period, Local Government Board Inquiries have been held upon 226 subjects affecting my department, for new works and improvements, involving the expenditure of about one-and-a-quarter millions sterling; and I have at the present time, for this Corporation, schemes in hand representing a cost of nearly a million sterling, for most of which the loans have not yet been obtained; and the routine expenditure by the various committees in matters affecting my office amounts to about 80,000*l*. per annum.

Regarding our every-day work, I cannot speak too strongly on the great necessity—as one of the best practicable means of safeguarding the health of the community—for Local Authorities being liberal in providing an adequate number of well-qualified and properly remunerated building and sanitary inspectors, working under able administration.

The good effect of the great sanitary works and efforts of this Corporation is vividly shown by the steady and maintained diminution of the death rate. The average from all causes during the decade of 1861–71 was 25·95; 1871–81, 24·47; 1881–91, 19·38; and during the last decade, to 1901, only 17·54.

With regard to the designing of the various classes of public buildings, in some towns a separate architectural department has been organised. In Leicester the ordinary architectural work is done by my staff, and the most important public buildings by our architects in private practice. Nevertheless, in connection with all these, an immense amount of preliminary work necessarily falls upon the Borough Engineer in advising and assisting various committees, preparing preliminary plans and estimates with detailed conditions for competitors, and out-

lining the schemes before the work reaches the architects. This is, however, I think, a far preferable plan than to set up an architectural department outside the control of the Borough Engineer, and much more fair to the architectural profession.

Referring, in passing, to other departments, the town owns the gas, electric light, and water undertakings; and Parliamentary powers have been just recently obtained, jointly with Derby, Nottingham, and Sheffield, for carrying out the great Derwent Water Scheme.

Since 1889, 120 miles of public and private foul and storm-water sewers have been laid in the borough.

Mr. Gordon's Intercepting Sewerage Scheme and Pumping Station has been carried out at a cost of about 163,000*l.*, and has proved very successful; and my Storm-Outfall Scheme, which many of you saw in progress, and which has cost about 80,000*l.*, has also been completed.

It is, however, one regrets to say, not unusual for municipalities, after having provided ample intercepting sewers, to leave in use in old and densely populated parts of the towns, defective and dangerous sewers of the worst types, such as used to be designed and laid before the days of our Association.

Several years ago I drew attention to the existence of many miles of such sewers in Leicester, and the probable ill-effect upon the inhabitants living in those districts. I was promptly instructed to examine and report upon them, with the result that I condemned 32 miles and am now carrying out a scheme to replace them, which I have designed and which is estimated to cost 128,000*l.*

This brings me to the subject of sewer ventilation, and, although we have not yet arrived at unanimity of opinion on this question, the chief trend of practice has been in the direction of the abolition or reduction in number of surface grids and the increase of shaft ventilation.

In Leicester I carried out tests during a period of between five and six years and made over 3000 observations of the velocities obtained in the shafts, besides very numerous records of temperature, humidity, wind velocity, barometrical pressure, and the like.

These practical experiments convinced me that sewers could be efficiently ventilated by pipe-shafts alone, in conjunction with very ample means of flushing.

After the results of these experiments had been submitted at an inquiry here, the Local Government Board passed the first section, namely, of 8 miles of the before-mentioned Tributary Sewerage Scheme, with ventilation provided by shafts, without any surface grids whatever—a new departure in the requirements of the Board.

No surface grids are now provided on any new public or private sewers laid down in this town.

The purification of sewage is one of the greatest and most perplexing questions that has confronted Municipal Engineers. Many have experimented and there is still much difference of opinion.

The investigations of the present Royal Commission on Sewage Disposal have already been very extensive, and will doubtless prove the most exhaustive and valuable research on record. Some think that the Local Government Board might now relax their requirements, and pass schemes for bacterial treatment alone. This is not surprising, having regard to the success which has been obtained by bacterial methods. I have, however, maintained that until sufficient experience has been gained to prove that the sewage of the manufacturing towns can be successfully and permanently purified without application to land, the Board are justified, in the main, in adhering to their present attitude, for land is an immense safeguard in connection with any sewage scheme.

Still, in cases where it is almost impossible, except at a prohibitive cost, to obtain it, I believe that the requirements of the Board might reasonably be modified. In fact, leniency has already been shown in special cases, and we may probably expect greater facilities when the eagerly awaited Report of the Royal Commission has been issued.

Some of the main questions at issue are:—

(*a*) Whether the sewage of manufacturing towns and districts can be successfully treated, with maintained efficiency, without application to land.

(*b*) Whether it is better to adopt the fullest anaerobic preliminary treatment in covered septic tanks, with final purification in contact beds, or whether only to employ a partial anaerobic treatment in open or closed tanks, with a maximum aerobic purification in contact beds.

(*c*) Further, whether preliminary chemical treatment may

not also be necessary in some instances where strong trade liquids obtain.

The question of intermittent or continuous treatment in the contact beds is also a debatable point, but the extreme aspect is whether, even where suitable land is available, it would not—if admissible—be more desirable to adopt bacterial treatment entirely than a combination of it and land treatment.

Again, what is to-day the best course to adopt where existing sewage farms, for want of sufficient area, means of preliminary clarification, or other causes, yield more or less unsatisfactory effluents?

The local conditions and the character of the sewage vary so considerably in different towns and districts that it is obviously impossible to determine upon any one system which would be universally applicable.

These questions can, however, be more reliably dealt with by giving you facts as to how we have successfully solved the problem for Leicester than by mere expression of opinion.

Twelve years ago, when I came here, and up to 1891, the river Soar in summer-time was a black stream of horribly offensive sewage matter, which, in that highly putrefactive condition, reached miles down the river, although everything was done, at unlimited cost, in chemical treatment at the old works.

In consequence of the difficulty of obtaining porous land in sufficient quantity and suitable locality, my predecessor had, much against his will and advice, to fall in with the adoption of our present exceedingly dense clay farm at Beaumont Leys—which, it was widely prophesied, would result in failure. The first contract, amounting to 10,400*l.*, for receiving tanks, carriers, culverts, etc., for part of the farm, was well in hand when I succeeded Mr. Gordon. The total cost of laying out has been 59,025*l.*, or about 43·56*l.* per acre for the 1355 acres actually prepared for receiving sewage.

The great problem then before us was how to so lay out, prepare and under-drain the land for broad irrigation as to ensure efficient purification, and to prevent the foul effluent which always reaches the drains of a clay sewage farm from getting away to the watercourses. This we succeeded in doing by providing for each field a separate system of drainage, so designed that the foul drain effluent can be brought on to the surface of the sloping land and treated over and over again until fit to

send away. This, with other arrangements, together with the services of an exemplary committee and efficient farm bailiff, resulted in our dense sewage being purified for over nine years to the satisfaction of the Leicestershire County Council.

The increase of the population and the trade has been very great, and these factors, together with the conversion of 6700 pail-closets into water-closets and the proposal to pump the sewage from the 12,000 population of the added area of Belgrave, rendered it necessary to either increase the area of the farm or to adopt some means of preliminary clarification.

I have been allowed to carry out very extensive bacteriological experiments. Altogether, seventeen different processes were tried, with two chief objects in view:—

1. The preliminary clarification of the sewage before application to old pasture land and rye-grass for final purification, without fouling the crops.

2. Complete bacterial purification without application to land.

For preliminary clarification, the system found most successful and suited to our requirements was to pass the screened and pumped sewage through a detritus tank of comparatively large capacity, then through a coarse-grained first-contact bacteria bed on the intermittent system, the effluent therefrom being finished on grass. By this process eminently satisfactory effluents were uniformly obtained, notwithstanding the heavy nature of the land, and much less than half the land was required to be used than when crude sewage was applied. The final purification on the old pasture was at once a most reliable and effective process and entirely free from offensive smell.

The process for complete bacterial treatment which gave the best results was the passing of the screened and pumped sewage through the detritus tank as before, then through treble contact beds, and the effluents from this process were only just equal to those obtained from the detritus tank, single contact, and irrigation on grass land.

The detritus tank and double contact process was not quite equal to either.

These results were only determined by very numerous and exhaustive observations and analyses. I consequently advised the Corporation to purchase 1270 acres of the land now leased to them, in addition to the 100 acres of freehold they already

possess, and prepared a bacterial clarification scheme to assist the land, consisting of open detritus tanks with a capacity equal to one-sixth of the present eight million gallons dry-weather flow to be dealt with, and twelve acres of first contact bacteria beds, which, together with the effluent pumping plant, new sewerage, and pumping station for the added area of Belgrave, is estimated to cost 168,000*l*. This scheme has been unanimously adopted, and application has been made to the Local Government Board for sanction to borrow this amount.

Great inconvenience has been experienced throughout the country for want of a general Act of Parliament giving Local Authorities greater facilities for improving small rivers, brooks, and ordinary watercourses in their districts, particularly where improvement works necessary for the prevention of flooding of lands and dwellings are too small to justify the obtaining of a Local Act of Parliament and too great to be defrayed out of the Revenue Account.

The flood which occurred at Leicester on the last day of the nineteenth century was the greatest here within living memory. Our great Floods Prevention Works, which were mostly designed and carried out by Mr. Gordon and Mr. Griffith, and brought to completion by myself, at a cost of about 352,000*l*., were constructed to carry off a volume equal to the whole of a rainfall of one and two-thirds of an inch in twenty-four hours from the 147 square miles of drainage area, and the volume of the flow which was actually discharged and also successfully carried off during that flood was equal to a rate of rainfall of nearly one and three-quarters of an inch in twenty-four hours. These are valuable and useful data in connection with the preparing of Floods Prevention Works.

I have recently designed and constructed in stone and concrete another bridge, besides those dealt with at your last meeting here, forming a new road from the Newarke over the flood course, at a cost of 15,500*l*., which you will inspect, and I have prepared drawings and a description of it for our volume of Proceedings. I am now designing a bridge to replace an old one of inadequate span at Belgrave, which will probably cost something approaching 25,000*l*.

I am quite unable to give you details of our different works in this address, but shall be pleased to supply later on any particulars which may be desired by you.

The rapid growth of large towns demands, for the sake of the health and vigour of all classes of workers with muscle or brain, for the children, and for those to whom we are so indebted for home comforts, that ample open spaces and conveniently located parks and recreation grounds be provided. In Leicester we have now 410 acres of parks, recreation grounds and children's playgrounds, altogether twelve in number, including our beautiful Abbey Park, which was opened in May 1882, by our present King and his beloved Consort, and it has proved a great boon to the people.

Including the above and the 1270 acres of land of the Beaumont Leys Sewage Farm, now being purchased by arbitration, and the different estates, the Corporation will own altogether no less than 2442 acres of land and properties for various purposes, exclusive of gas and watèr; and so convinced are they of the advantages which would accrue both in health and financially with more power to acquire surrounding land, which is ever increasing in value, that they are far from satisfied with the facilities the present legislation affords.

The provision of public baths and open-air bathing stations is essentially an important health question, and there is now a tendency to combine water sports to a great extent with swimming and to utilise the main buildings for gymnasia in the winter, with the maximum possible accommodation for spectators.

Our Cossington Street Baths are on this principle.

We have now three public baths and two open-air bathing stations, and we are about to build another set, involving altogether an expenditure of about 50,000*l.*, exclusive of land.

The last-mentioned baths are to be erected at the West Humberstone Refuse Destructor, from which the heat will be supplied. The swimming baths will be on the amphitheatre principle, with dressing boxes under the seating, and, in lieu of the ordinary slipper baths, 24 combined washing and hot vapour baths will be provided.

In electric traction for our streets and roads there is now opened out an immense field and future for Municipal Engineers. In conjunction with electrical engineers, they have already played a very prominent part in the designing and carrying-out of schemes in our large towns.

There have been much greater enterprise and progress abroad than in this country, both in manufacture and construction,

and from which we have derived much advantage; but all this is being rapidly changed and to-day we possess in some of our cities and towns overhead trolley systems, power stations, depôts and various accessories of the very best types, with approximately about a thousand miles of electrically equipped tramway track now in operation, mostly put down within the last decade, and several hundred miles are under construction.

But perhaps nearly twenty times as much as this has been electrically equipped in the United States, and a vast aggregate mileage throughout the Continent. It was high time we moved. Foreign companies and capitalists are not only reaping the benefit of our traction, but are exploiting this country for the purpose of financing and carrying out tramway undertakings which our countrymen, who, in the past, have been great pioneers in railways and other engineering works, ought, for the honour and prosperity of the kingdom, to rouse up and do themselves, while at the same time encouraging and fostering such interchange of trade with other countries as is mutually advantageous.

Leicester, although usually in the front, is at present behind in electric traction—chiefly because the tramways are still in the hands of a company—but we intend to come into line, at least, very soon.

Although the overhead system has been chosen by every provincial town in the United Kingdom which has hitherto carried out a scheme, the objections to it have been so deeply rooted that a most exhaustive investigation has been made by us in the hope of finding something better, but we found nothing excepting the overhead trolley which sufficiently combined reliability, safety, economy and efficiency for a town like Leicester. We, therefore, recommended it, and also a separate and independent central power station.

Our preliminary scheme, which I had the honour of preparing for our sub-committee, has been—by the full committee —unanimously recommended to the Council, who have adopted it, subject to the site of the power station being in abeyance for the present, and I have been instructed to prepare the Parliamentary and working plans, etc., for the scheme, with Mr. E. Manville as consulting engineer.

No detailed estimate has yet been prepared, but the present scheme embraces 22 miles of route, and about 38 miles of track

and, as to cost, half-a-million sterling is a guess which goes unchallenged, without including the purchase amount of the present undertaking.

I feel convinced that in provincial towns much more will be done to solve the question of the housing of the working classes by electric tramways than by the erection of blocks of workmen's dwellings in thickly populated centres.

Small separate dwellings on the extreme outlying parts of a town conduce greatly to the improved physique and respectability of the people, especially when allotment grounds are available within easy reach. We found that the experience in Brussels had been that it was not necessary to wait for the growth of a suburb before making a tramway, but that when a tramway is put down it makes a suburb, and that, as unhealthy houses had been demolished in the centre of the city, the working classes gladly availed themselves of the cheap and rapid tramway transit, and went out to the healthy dwellings which were soon provided, at reasonable rents, by private enterprise.

There is undoubtedly a great future for the auto-car for light work, swift and convenient transit, and, as greater perfection with regard to fuel, engines, gearing and reduction of noise is attained, it will gradually effect a great sanitary improvement and will considerably diminish the wear and tear of our roads and streets in comparison with horse traffic. Smart men will be their own drivers and mechanics; they can live long distances from their business and can have their railway station in their own backyard. Notwithstanding its great promise, the motor-car is not likely, however, to supersede electric traction for public service, although very useful for feeders and auxiliary traffic.

In the principal thoroughfares of large cities with electric tramcars, a one-minute service running each way is no unusual thing. This means something like 7000 persons passing a given point to and fro every hour, in an undeviating course, swiftly, smoothly, and almost noiselessly, and without any confusion whatever; and even three or four times that number is quite practicable, without inconvenience.

I wish here to take this—my earliest—opportunity of publicly thanking the members of the Automobile Club of Great Britain and Ireland, and of its Nottingham and Midland

branches, for their great kindness in undertaking to bring their cars from different parts of the country to convey our Members on their various visits in Leicester and the surrounding districts on Saturday. This excellent and unique event was kindly suggested to me by our confrère Mr. E. P. Hooley, in conjunction with Mr. A. R. Atkey, honorary secretary of the Nottingham Club. The utility and advantages of motor-cars will be practically demonstrated, and a great treat is expected. I, therefore, request your very hearty co-operation on that occasion.

I must not omit to draw your attention to the advance which has been made in steam road locomotion of late. For years past road locomotive engineers have devoted their energies to placing steam on common roads on a commercial basis. We well know that with heavy steam road locomotives the hauling of loads of from 15 to 30 tons can be done at an extremely low cost per ton mile, but the Locomotives on Highways Act, 1896, has produced a smaller and handier means of doing the work of several horses at an inclusive cost of less than 4*d.* per ton per mile. With regard to municipal work, several of the London and other corporations are already using steam wagons for carting materials, watering streets, dust and refuse collecting, etc., and it is claimed to effect a considerable saving in cost.

What the future development of the steam wagon will be it is difficult to foretell, but the tendency will be towards simplicity of construction, higher quality of materials used, higher power of engines, increased pressure of steam and greater economy.

Nor are these light locomotives likely to increase the cost of upkeep of the roads themselves, for it must be borne in mind that, with horse haulage, besides the pressure of the wheels bearing the load on the road, the deteriorating action of the hoofs of the horses must be taken into consideration.

The present use of horseflesh for transporting more or less heavy loads, especially on steep gradients, is, in these days, hardly worthy of science.

One of the latest matters which we have to advise upon is the provision of short rifle-ranges, similar to those at Wormwood Scrubs, which, it is urged, can be placed with safety within easy reach of every town or thickly populated district, and thereby give facilities for all our men to learn to shoot. If such a voluntary training movement would, as some think,

tend to so strengthen our nation as a fighting power in case of need as to substantially diminish the necessity for a very much larger permanent Army, or to prevent the sacrifice of our sweet liberty by Conscription, then every legitimate means towards this end might well be adopted by our Local Authorities. Our colleague Mr. J. W. Bradley, having taken much interest in this subject, has kindly undertaken to read us a paper upon it.

The position of a Municipal Engineer is one of infinite variety of work and responsibility in so many branches of routine and professional duty, with a consequent strain far exceeding that brought upon his more fortunate and better-paid confrère in private practice.

Again, besides the unlimited theoretical and technical skill required, a successful Municipal Engineer must possess that peculiar power which enables him to organise and direct human effort to the best advantage and to lead and control large numbers of men—qualities which are of superior value in every sphere of life; and it is to be hoped that Local Authorities will remunerate their own permanent engineers and surveyors to an extent fairly commensurate with their services, and thereby relieve them of the anxiety of the financial burdens brought upon them by their never-ending professional education, the upholding of the respectability and integrity of their positions, and the meeting of the many claims for all sorts of objects, learned societies, etc., which their office demands; for I venture to say that many an able, exemplary and frugal official is by no means free from such anxieties, simply because he is not adequately remunerated, although he does much extra work, which would otherwise cost the ratepayers vastly more than would a reasonable increase of salary.

Security of tenure of office is a subject which has seriously exercised the minds of many, chiefly owing to unfortunate circumstances which, in several instances, have ended unfairly to the officers. It is, however, a delicate and difficult question, and, whilst some protection is needed, any attempt to restrict unreasonably the power of Local Authorities would not tend to promote either the comfort or advancement of the officials.

Superannuation for the officers of Municipalities and Local Authorities generally is a question which, I venture to respectfully say, has by no means yet received at the hands of those Authorities the consideration it fairly deserves, although it

must also be said that among the duly elected representatives of the ratepayers throughout the country it has many ardent advocates.

Some towns, including Leicester, have obtained Parliamentary powers for local superannuation schemes, and some, including Liverpool, have adopted and worked them.

What is needed is a general Act, extending to all officers of Local Authorities the provisions of the Poor Law Officers Superannuation Act.

The present Local Authorities Officers Superannuation Bill has been supported by several Municipalities, but the Government will not adopt such a measure until the majority of Local Authorities have petitioned in favour of superannuation. This seems hopeless at present.

The difficulty might possibly be partly met for a time by a measure giving each respective Authority the option of adopting the Act whenever they might become sufficiently convinced of the wisdom of such a step.

The arguments in support of the justice of the case cannot be adequately dealt with in this address. I cannot leave this question without urging our Members to support, as far as able, our admirable and much needed Orphan Fund Movement.

It would be almost impossible to over-rate the extent to which our Association has improved the status of Municipal Engineers, largely by the great facilities afforded for the interchange of opinions and the obtaining of knowledge and information so willingly imparted by our Members to each other in every sphere of their work. Neither can one over-estimate the advantages accruing to Local Authorities from the experience gained by their officers attending our meetings and inspecting the numerous and varied works of our confrères, especially when one considers that a very large proportion of the sanitary works of the country have, of late years, been done by the stipendiary officials of Municipalities.

Our Association, particularly by its examinations, has been the means of bringing forward many well-educated and clever young engineers into our ranks.

I believe that the time is fast approaching when no young engineer will be considered duly qualified for a chief appointment who has not passed this or an equally comprehensive engineering examination.

The profession and work of Municipal and County Engineers are of hardly less value and importance to the country than those of members of other leading professions, and our Association, with its roll of nearly 1000 Members and Graduates, representing practically the whole of the cities, towns and districts of the United Kingdom and our Colonies, may be fairly entitled to equal recognition with all other prominent institutions.

I think we might with advantage allow our list of eminent honorary members to be extended to admit more of the distinguished engineers and scientists of our country and of the Continental cities and America, so as to facilitate to an even greater extent comparisons of practice and the promotion of knowledge in all branches of Municipal work.

PERMANENT WAY FOR ELECTRIC TRAMWAYS.

By W. HOWARD-SMITH, Assoc. M. Inst. C.E.

The Author responds with pleasure to the invitation to submit a paper on this subject, one no doubt of interest to many municipal engineers, and as it has not been dealt with in any previous paper presented to our Association, he trusts the following notes may at least afford an incentive to an interchange of experiences and ideas from those either at present engaged upon tramway work or who contemplate taking it up in the near future.

To successfully design tramway permanent way necessitates the most careful consideration of a multiplicity of small details, many of which may, to the inexperienced, appear of insignificant import, but a closer analysis will show how greatly they may affect the stability, ease of running, cost of maintenance or life of track.

A well designed track which is the outcome of practical experience will probably have a life double or treble that of one badly conceived. Each year added to the life means not only a saving of the proportion of capital cost and interest thereon, but also the postponement of the inevitable loss of revenue during reconstruction; every possible means should therefore be taken, at reasonable expense, to ensure that the permanent way shall be perfect in design and construction and its standard of stability of the highest.

Though the experience in this country of the wearing effect of electric traction on tramways has been comparatively short, it has been sufficient to conclusively demonstrate that it is much more exacting in its demands for perfection of permanent way than was found necessary under horse, cable or steam traction.

This is primarily due to heavier cars being run at much faster speeds and with much greater frequency. A loaded

electric car weighs from 10 to 12 tons as against 3 to 4 tons for a horse or cable car; while the maximum speed is generally fixed at 8 miles per hour on urban and suburban, and 15 miles per hour on inter-urban lines, these speeds being subject to further restrictions where there is a density of vehicular or pedestrian traffic as also at sharp curves; when entering or leaving passing places cars are supposed to slow down to 4 miles per hour, but it not unfrequently happens that in actual working these speeds are somewhat exceeded.

Electric cars are equipped with more powerful brakes, which are more frequently put into requisition, with attendant use of sand, causing wear. On some steep grade lines no less than four brakes are provided to the cars, and the Board of Trade have required that, in addition to the usual electric and hand-wheel brakes, wood slipper-brakes, about 18 inches long, shall be constantly applied to each rail on the down-hill journey, and in one case a special brake or pilot-car with similar brakes is run in front of the passenger car. Perhaps the most powerful brake is the "scotch," applied to both wheels and rail.

The better the permanent way the more use is made of it by vehicular traffic, especially of the heavier kind, quick to take advantage of the lessened tractive effort necessary when cart wheels are run on the smooth rail surface. This is particularly the case when track is of 4-ft. 8½-in. gauge, which nearly approximates to the usual width apart of wheels on vehicles. So obstructive to car traffic and detrimental to the wear of the track has vehicular traffic been found in some large towns that the authorities are endeavouring to obtain powers to relegate it to the sides of the carriageway, but a frequent car service generally results in practically sweeping other vehicles off the track.

Rails.

An ideal tramway track would be one in which, in addition to providing perfectly smooth running for the cars and being unobjectionable to ordinary street traffic, each part would have a similar period of life; this, however, is unfortunately far from realisable.

Assuming the work to be well executed, the concrete is practically for all time, and the paving, if of granite or other hard stone, may last twenty or more years, whereas the life of the

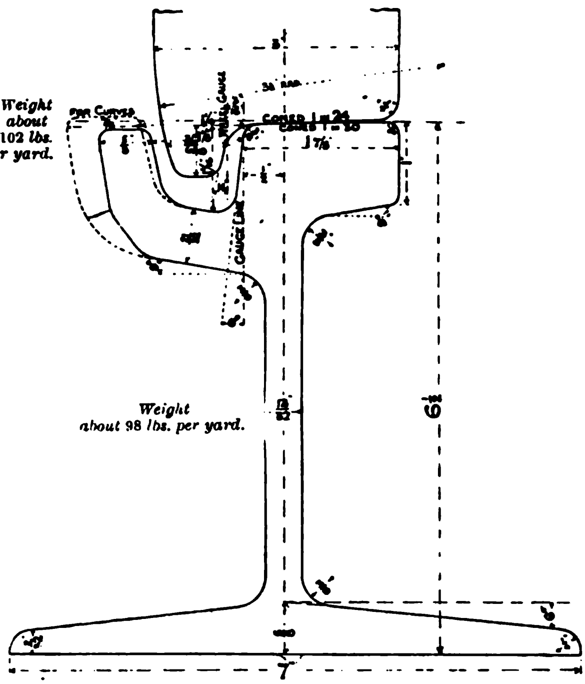


FIG. 1.

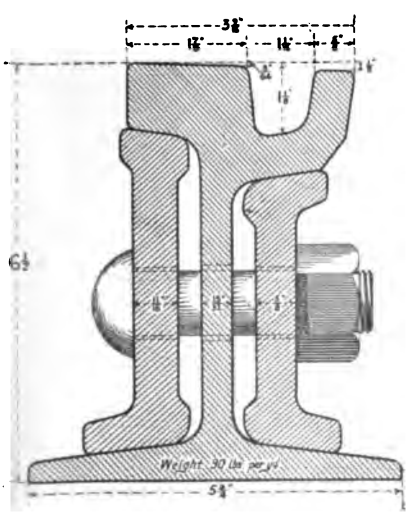


FIG. 2.

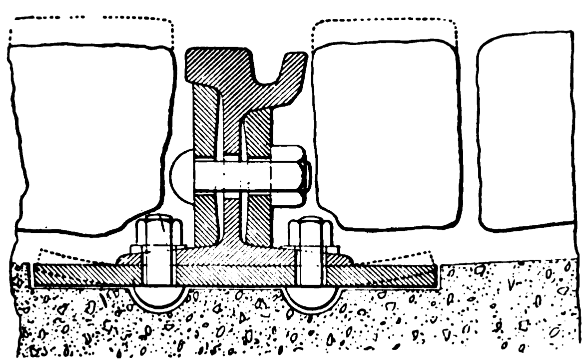


FIG. 3.

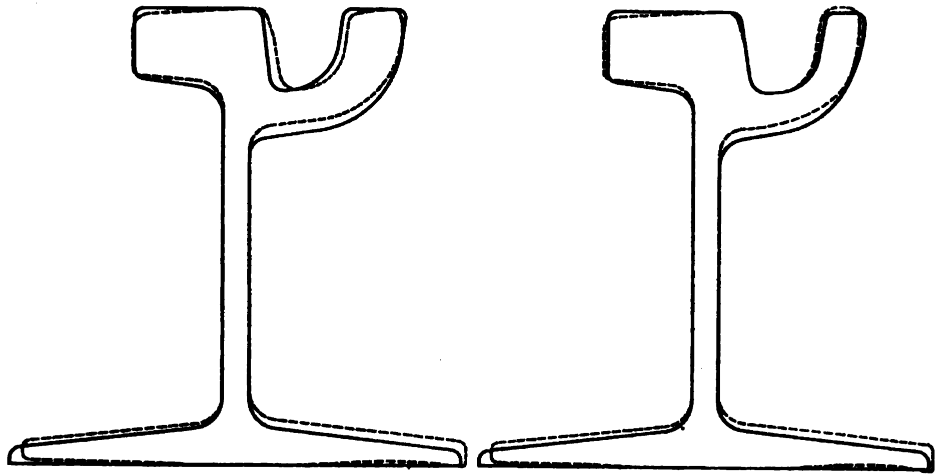


Fig. 1A.

"PHŒNIX" RAIL JOINT

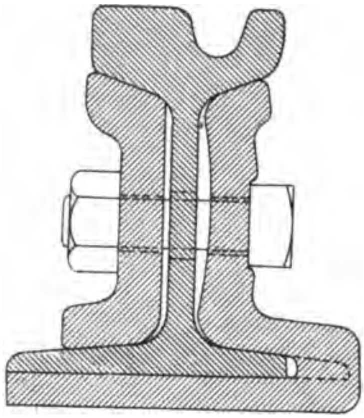


Fig. 4.

"DICKER" RAIL JOINT

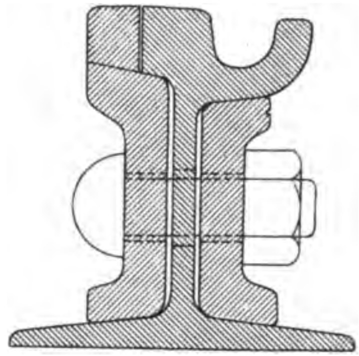


Fig. 5.

"VICTOR" RAIL JOINT

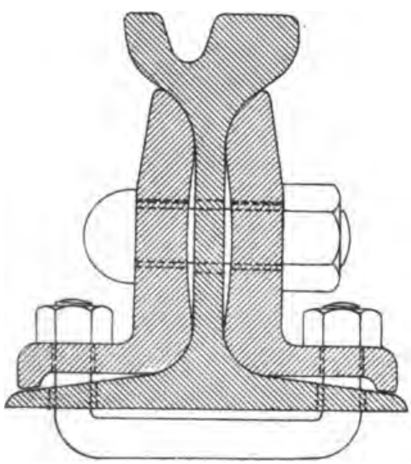


Fig. 6.

"CONTINUOUS" RAIL JOINT

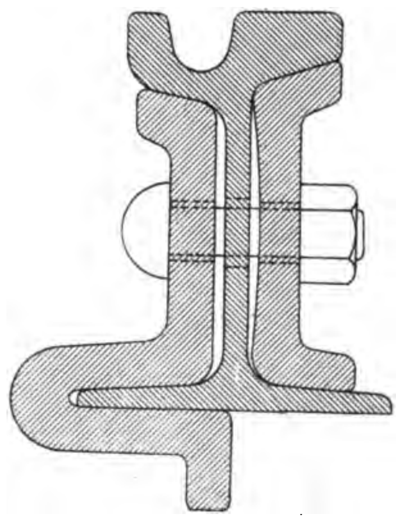


Fig. 7.

LORAIN STANDARD JOINT.

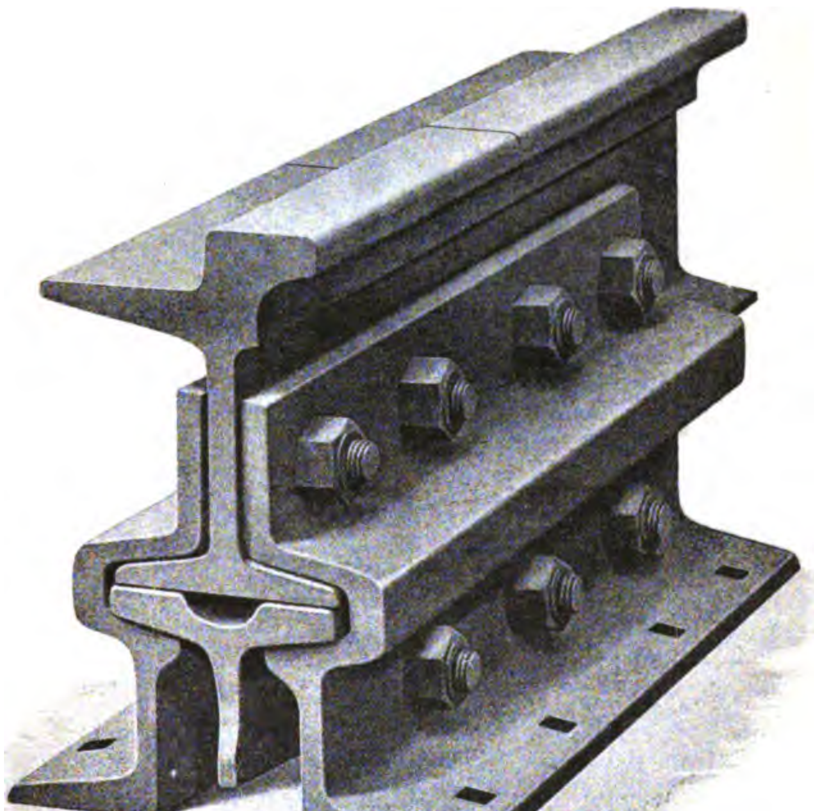


Fig. 8.

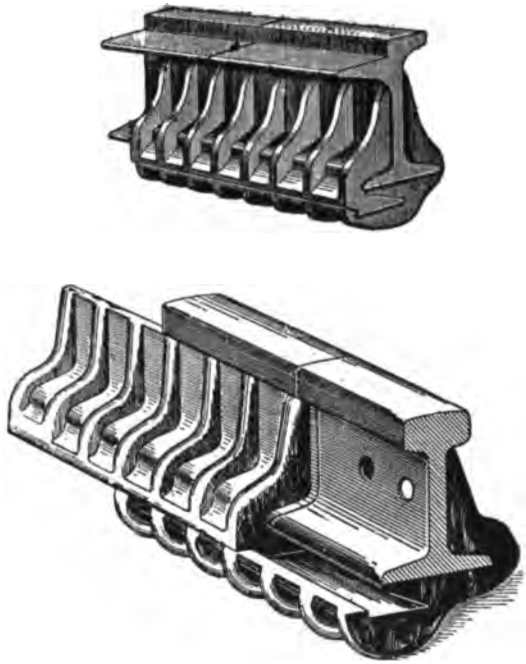


Fig. 9.

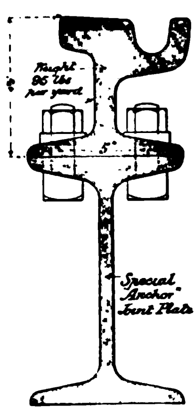


Fig. 10.

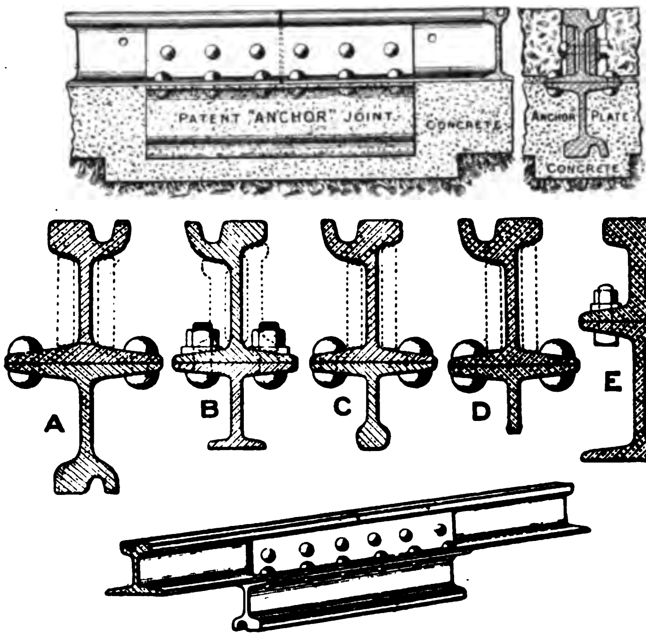


FIG. 11.

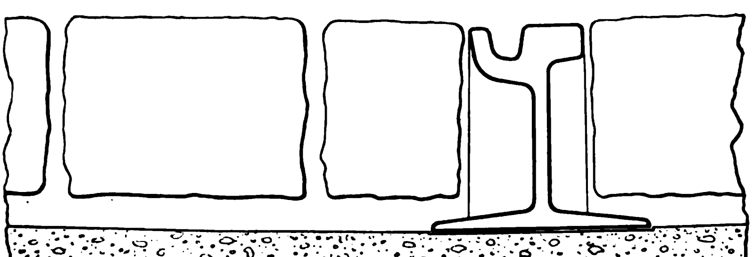


FIG. 12.

rails will be much more limited, and as their renewal entails relaying the paving and other work, it behoves the engineer to give earnest consideration to every detail tending to obtain longer life in the rails, which, with their accessories, it is not too much to say form the most important part of the track.

The main duties of a rail are: mechanically, to carry the car and vehicular traffic passing over it; electrically, to act as a medium for conveying the return or negative current back to the power-house. For this latter purpose it is immaterial in what form the metal is disposed so long as a certain minimum sectional area is provided. The Board of Trade have recently made a pronouncement that this minimum shall be such as to be equivalent to a rail weighing 90 lbs. per yard, i.e. one having a sectional area of about 9 sq. inches for a hard steel rail having a conductivity of about $\frac{1}{12}$th to $\frac{1}{14}$th that of copper. The general practice now is to go even beyond this; perhaps from 95 lbs. to 100 lbs. per yard may be considered the weight most desirable. Mere weight alone is, however, of little value as affording a criterion of the strength, stability, ease of running or wearing qualities of a rail: it depends how this weight is disposed, i.e. upon the section or profile, and also upon the chemical constituents.

While the section should be such as to provide great vertical and lateral stiffness, the profile of the head of the rail (made up of the tread, groove and guard), which shows on the street surface, must be such as not to interfere with the general traffic, and its total width should be as narrow as possible.

Until very recently, by the Board of Trade Regulations the groove was limited to 1 inch in width and depth, being varied only in one or two exceptional instances where railway rolling stock also passed along the tramway rails.

Of late this has been relaxed and grooves of $1\frac{1}{4}$ inch in width and depth have been approved. Undoubtedly a wide groove is an advantage by admitting a thicker and therefore stronger wheel flange to be used; and it is particularly desirable at curves to allow free passage of flange without friction against sides, and straining of underbody of cars when of long rigid wheel base. But with a wide groove on the straight, more side-play is allowed to wheel flange, and therefore the greater the force of impact and vibration, through flange striking sides of groove;

again, larger stones, pieces of metal, etc., and more dirt can enter, and there is a greater reservoir capacity for surface water to be splashed up by a passing car into the bearings and motor gearing, with the possibility of damage resulting.

With a wheel flange ⅞ in. thick, a width of groove of 1⅛ in. should be ample on the straight and for curves with larger radius than 75 ft. For curves of from 75 ft. to 50 ft., radius 1¼ in. width will usually be found sufficient, while those of less radius should never be used; if they are, there will be grinding and great wear, but much depends upon the profile of groove apart from width and depth. It should not be forgotten that the effect of wear is to widen the groove, and that a wide groove is an element of danger to cyclists, tradesmen's tricycles and other narrow-tyred vehicles.

While the purpose of the guard or lip is to form a guide for the wheel flange, it must be strong enough to sustain vehicular traffic coming upon it. It is desirable that the top of guard be made slightly lower than tread as latter wears away the quicker; dirt can be also easier cleaned from groove. For curves, where the guard is subject to be ground away by friction from wheel flanges, it should be made thicker and slightly higher.

The web should be so placed that its centre is as nearly as practicable below the tread, so that the resultant of the forces from rolling load of car and lateral pressure of wheel flange shall fall well within the base, otherwise there is a tendency for the rail to tilt under the forces coming upon it.

It should, of course, be perfectly vertical; in badly rolled rails the web is often at an angle and much crippled. An example of this may be seen among the specimens shown: this was not in any way selected, but is a fair sample of the rails used.

The base should be sufficiently wide to spread the superincumbent weight on the concrete underbed and to resist the ide tilting motion referred to.

Standard Rail Section.

The general adoption in this country of a "standard" rail section is much to be desired. It is difficult to enumerate the

many advantages that would follow therefrom. Certain it is that it would assist to great economy, simplification of detail, and more perfect rolling, Fig. 1A, and manufacturers would gladly welcome it. The cost of a set of finishing rolls alone is about 200*l*., which is, of course, eventually borne by the consumer, and they will only suffice to roll a limited quantity of rails, so that it does not pay manufacturers to specially prepare them unless for a large quantity.

With the present multitude of sections (as shown only partially by Table in Appendix, and illustrations), which are being constantly added to, it becomes impracticable for rail makers to stock rails; but with a "standard" section, rails would be kept in stock of various lengths, including those for joining up to points and crossings, which have now to be cut on the ground in a somewhat rough and ready manner, and at much trouble and expense. Were the disadvantages that arise from the great variety of sections at present employed, and the great advantages that would ensue from the use of a "standard" section, all detailed, but little room would remain for dealing with other matters within the limit of this paper.

Disadvantages are not so apparent in the first laying of a track when large quantities of rails are required, but should small lots be hereafter wanted for extensions or renewals it will probably be found impracticable to obtain them of the same section without fresh rolls being made, or, should rolls exist, at an enhanced price, as it costs a considerable sum to put in a set of rolls, and these difficulties will be still more emphasised with foreign sections.

Imagine the result when a track becomes a patchwork of various rail sections, as has been the case on many old tramways, and is even the case in more than one instance on tracks recently constructed. Endless trouble, delay and cost will thereby be entailed.

Joints cannot be properly made, but cranking, joggling, packing or other unworkmanlike methods have to be resorted to, with the natural consequence that looseness and trouble at the joints is quickly experienced and rails have a very short life.

A "standard" section would also lead to a "standard" wheel tyre profile, giving much less trouble from broken or worn flanges and longer life—no small advantages.

The considerations before mentioned particularly apply to

points, crossings and special work. Take the case of cast crossings, which are made of various angles and which are often wanted at short notice to replace those worn or damaged; obviously it is impracticable to stock these of patterns to conform to the many sections, and if they have to be made, it may mean a delay of some months, whereas with a "standard" rail they would be stocked. Much greater opportunity would also be given for improvement; the present design and manufacture of points and crossings can hardly be said to have reached perfection.

The conditions to be complied with in a "standard" rail are so limited that there should be little difficulty in arriving at the best way of meeting them.

We have first a rail of a minimum weight of 90 lbs. per yard, with a head as narrow as practicable consistent with the duty it has to perform; experience shows that this should be about 3$\frac{5}{8}$ in., made up say of a 1$\frac{7}{8}$-in. tread, 1$\frac{1}{8}$-in. groove and $\frac{5}{8}$-in. guard. For curves less than 75 ft. radius, the groove should be widened to 1$\frac{1}{4}$ in. and guard made $\frac{7}{8}$ in. thick.

In Fig. 1 is shown the profile the Author would suggest as embodying the requirements of a "standard" rail. This would weigh 98 lbs. per yard for straight rails and 102 lbs. per yard for curved rails.

Except that the base width is increased, this is in fact very similar to one he designed some three years since for the British Electric Traction Co., and adopted by them as their standard rail; most of their lines have since been constructed with it, and it has also met with much general favour, having been adopted for use on a large number of tramways in this country, the Colonies and abroad. (A list of these is attached to Fig. 2.) This section is now known as the Barrow No. 494, the Leeds No. 23, and the Lorain No. 348.

With a "standard" rail, all accessories, fishplates, joint-plates, tie-bars, bolts, nuts, etc., could also be standardised. Similarly, tools—such as benders, jim-crows, spanners, saws, drills, etc.—could be largely of one pattern, instead of the present multitude, some good and some bad.

A standard specification of chemical constituents and tests is also desirable. It is not wise to use such a large percentage of carbon that there is little ductility left in the metal. The Author suggests:—

Carbon		·45 to ·55 per cent.
Silicon	max.	·08 „
Sulphur	„	·06 „
Phosphorus	„	·08
Manganese		·07 to ·10 „

Tensile, 42 to 48 tons per sq. in.; Elongation, 20 per cent. on a length of 18 in. with a contraction of sectional area of 50 per cent. Tup test, one ton falling 20 ft. on 5 ft. piece on 3 ft. supports, without causing fracture.

The present time is most opportune for a consideration of this question, as, in addition to the pronouncement of the Board of Trade, before referred to, a "Standards Committee," representative of the principal scientific societies interested, has just been appointed, at the instance of the Institution of Civil Engineers, to consider the question of standardising all sections of steel work rolled in this country, as has already become a *fait accompli* in America, Germany and Austria, with incalculable benefit to all concerned.

As the Members of this Association are those now most largely engaged as tramway engineers, no doubt their views upon the desirability of standardising tramway rail sections and specifications, if put in concrete form, would have considerable weight with such Committee.

Rails for car-house yard should preferably be of the Vignoles type, detachable guards being bolted thereto where necessary; by this means sharper curves are possible. It requires from 20 to 30 per cent. more power to run cars with a grooved rail than with a Vignoles rail, due to the side friction and also to running on the dirt in grooves.

When gauge is 4 feet or less, special L-shaped rails without overhang should be used for car-pits, so as to allow more room for taking out motors.

Rail Lengths.

Owing to the small proportion of rail area exposed, the remainder being embedded in the paving which is practically a non-conductor of heat, variations of temperature in this country do not appreciably affect the dimensions of tramway rails when laid. With a coefficient of expansion in steel of 0·0000065, such differences of temperature simply cause a slight change in the molecular condition of the metal within its elastic limit.

By the use of welded joints or rigid joint plates practically

forming a continuous rail, lengths of several miles have been laid without any provision for expansion, and this has also been the case in America, where ranges of temperature are much greater than in this country.

But if a rail be wholly exposed to atmospheric effects, there will probably be a measurable difference in its length at the hottest and coldest parts of a summer day; provision should be made for this when cutting rails for closers. The longer the rail the greater will of course be the expansion.

Until very recently tramway rail lengths were seldom more than 36 feet, but as it became recognised that provision was not necessary for expansion and contraction, and that the main element in the life of rails was the joints, with a desire to eliminate as many of these as practicable, rail lengths were increased until at present 60 ft. is quite usual; even 90 ft. has been proposed. Whether 60 ft. is the best length, or that it is preferable to one of 45 ft., is more than doubtful. The main argument in favour is that the number of joints is lessened, i.e. 196 per mile of track as against 232 with a 45-ft. rail

If the joints are bad and jolting, it is undoubtedly a comfort to passengers that there should be as few of them as possible; but assume that the joints are as smooth as remainder of rail —and there is no reason why by the adoption of efficient jointing devices they should not be so made—then all other considerations, including that of cost, favour the shorter rail. These considerations are too multifarious to detail here, but having used large numbers of both lengths and given much consideration to the various bearings of the question, the Author is of opinion that generally speaking the best and most economical track is to be made and maintained with a 45-ft. rail.

Rail Joints.

Even the best rails will have but short life unless connected together by thoroughly efficient joint-devices, as it is at the joints that the immense vibration, twisting and pounding effects from heavy electric cars are mainly experienced.

In America expense is not spared to secure a good joint, its paramount importance being recognised, but it is not always sufficiently appreciated in this country.

Naturally the use of an efficient joint will mean some addi-

tional cost over the ordinary fishplate joint, but the excess will at most be one or two per cent. of total, whereas the life of track may be thereby extended 50 per cent. or more, much more comfortable and easy running ensured, and much less current consumed.

Careful investigation shows that with fishplate joints the average wear is twice as great for a distance of about 12 in. from rail ends as at remaining parts, so that the joint governs the life of rail and consequently of track. This detail, therefore, demands much attention, to the end that a smooth and easy riding track with long life shall be ensured.

In this country fishplates have been until recently almost universally employed for connecting rail ends together; those having 4 or 6 bolts being general, but 8 and even 12-bolt fishplates have been used. Long fishplates add little if anything to the stability or life of a joint; indeed, consequent upon the increased leverage, they are likely to become a source of weakness.

Long fishplates were tried on railways, but the "survival of the fittest" shows that 4-bolt fishplates are now standard practice.

It seems to be inevitable that with joints formed with fishplates alone, no matter of what form, or however many bolts may have been employed, looseness is only a matter of time. The diameter of the holes in the rails and fishplates being necessarily larger than that of the bolts is one cause, and another is that it is impracticable to ensure such accuracy of profiles as will give a perfect fit between rail and fishplate.

As an American authority, Pressel, says:—

"Even with the most perfect methods of rolling it is not possible to obtain an accurate fit between the whole length of the fishplate and the head and flange of the rail. There can never be contact over the whole length of the fishplate, but only at a few odd points, which may be anywhere. Excessive stresses are unavoidably produced in the neighbourhood of these points; when the bolts are tightened pressures of an injurious character are set up.

"More particularly is this the case in the fishplates through the vertical pressure of the joint. In addition, the tightened fishplates tend to produce shearing at the head and flange of the rail, which leads to its destruction."

Experience abundantly shows that in themselves fishplates

are insufficient to provide a joint calculated to permanently maintain absolute rigidity and the other requirements of electric traction. Even on tramways constructed only within the last three or four years, and with long and heavy fishplates, there are frequent instances of loose and hammering joints, and of packing being constantly resorted to; though, as a rule, the weakness of bad joints is not made manifest until after two or three years' wear, but, once started, deterioration becomes rapid.

Herr K. Berger, a tramway engineer of recognised authority, says in a paper read at the recent Congress of the International Tramways Association:—

"Practical experience has shown, that with no fishplate joint can an even wear be maintained. Fishplates become loosened and bolts twisted under the severe punishing effect of electric traction."

The joint must be absolutely stable and unyielding. If there is the least looseness, the blows from passing cars become percussive or hammer-like, increasing in force as joint deteriorates, the rail ends quickly becoming surface bent.

The presence of bad joints may be easily ascertained, even when one is not riding in a car, if after the business hum has ceased in a town, one listens to an approaching car, when will be heard the rhythmic "bump, bump," as it passes over each loose joint.

As an American writer remarks: "There is a loud pounding noise which seems inseparable from the present form of spliced joints."

The inefficacy of fishplates has become so generally recognised that recourse is now usually made to some further device with the object of reinforcing them.

Perhaps the first device to be employed for fortifying fishplate joints was in the form of a flat plate or sole-plate bolted under the base of rail, introduced under Winby and Levick's patent in 1887, and, singularly enough, first used in the construction of the Leicester tramways.

Not proving entirely satisfactory, and with a view of spreading the stress over a larger area, these plates were sometimes made to extend beyond the rail base; but the wisdom of this is questionable, as the effect of the heavy car traffic is to cause these projections to tilt up and lift the setts above. (Fig. 3.)

With regard to the value generally of this device as assist-

ing to fortify the fishplates, Mr. W. Dawson, assistant borough surveyor of Bradford, in a recent paper, remarks that "sole plates were placed under the ends of the rails, narrow steel strips were placed on the top of the bottom flanges of the rails at the joints and the whole bolted together with six bolts. The joints still worked loose, and it is now recognised that this method is insufficient to make a perfect joint."

General experience fully confirms this opinion. Further, the use of these flat plates is exceedingly detrimental to the maintenance of a good track, because they form a sinking or well in the surface of the concrete directly under the junction of two rails where water collects, and from the hydraulic action set up by weight of passing cars the surface of the concrete is softened and otherwise much mischief is created, particularly in causing the rails to spring and the stone setts or wood blocks to work loose and rise above rail level.

There have been numerous later devices for the reinforcement of the ordinary fishplate joint.

Among those which in themselves are practically modifications in some form or other of the fishplate principle, are the Phœnix (Fig. 4), the Dicker (Fig. 5), the Victor (Fig. 6), the enclosing fishplate or Continuous Rail Joint (Fig. 7), the Churchill and the Weber.

The success of most of these methods is largely dependent upon a more than usual accuracy of profile in rail, fishplate and joint plate to enable the various parts to fit perfectly together, otherwise stresses in joint or on bolts may be set up, which were not contemplated or provided for, and any strength calculated to be given by the joint piece nullified—indeed it may happen that in, say, tightening the fishplate bolts, the sole plate bolts will be stripped or *vice versa*.

When joint devices are employed which depend greatly upon perfection in fit, the surfaces should be thoroughly cleaned from rust and scale; for, as Mr. M. D. Pratt, an American authority, points out:—

"Rails fresh from the mills are covered more or less with a thin coat of black oxide of iron; much of this falls off during the process of straightening and handling, but there is always some adhering to the rail when placed in the track. This is one of the worst enemies of the joint, for after the latter is applied and the track is used, the jar of passing wheels reduces

this scale to a thin powder. This powder, working its way out from between the rail and joint plate, leaves the latter loose or well started in that direction. This coating of oxide or scale is also found on the joint plates, therefore the first thing to do is to remove it from the bearing surfaces, which may be done by a hammer, file or scraper. This matter is of considerable importance."

When a fishplate is raised to form part of rail tread, it should be composed of metal of equal hardness to rail (usually fishplates are softer), otherwise the surface will "roll out" and give an appearance of stability which may perhaps hardly be warranted. Such fishplate should also have its fishbolts as high as possible to prevent the upper part becoming the long arm of a lever, with fulcrum at point of bearing of fishplate on upper part of rail base, which condition would, with car running on upper surface, tend to force the nuts and strip the threads of fishbolts.

It is questionable whether fishplates should be relied upon as the principal means of connecting tramway rails, or whether they should be considered only as an auxiliary to a more effective form of joint-piece utilising the broad flat base of rail.

The following summary of a recent report of a German State Commission is evidence that this method is now favoured by engineers of experience: "They recommended that side fishplates should not be used, as it had been found better to use joint plates which would utilise the broad lower surface or flange of rail. Light side fishplates might perhaps be used to still further assist against transverse stress; however, the experiments made showed that their use is superfluous."

The utility and advantage of the base-plate method is also recognised in the Lorain joint (Fig. 8), and in the Wheeler joint (Fig. 9), both of which have been largely used in America.

It will be noticed that while there are fishplates to the Lorain joint they do not touch the underside of rail head, and the makers of the Wheeler joint say:—

"There is no attempt to assist the web in holding up the rail head, as we believe the province of a rail joint is to prevent motion of rail ends by keeping the bases and webs in perfect and immovable alignment, thus insuring permanent alignment and surface of the head."

At Blackpool fishplates are entirely dispensed with, reliance

being wholly placed upon "Anchor" joint plates fixed to the base of rails (Fig. 10). It will be noticed that the rail section here used, while weighing 95 lbs. per yard, is novel in being only 4½ inches deep, the view of the engineer, Mr. Quin, who designed it, being, the Author believes, that as a tramway rail has a continuous bearing, and is not therefore subject to deflection, it is not necessary to have a depth beyond that sufficient for the paving, so long as ample depth and stiffness are provided at the joint, which is, in this case, attained by the "Anchor" plate.

A similar view is now held by many engineers, who point to the waste of material involved in a very deep rail, mainly in order that it shall have sufficient depth at the joint; but there are other points to be considered and it is questionable whether a shallow rail will prove a success on an electric tramway.

As engineer for the construction and maintenance of a number of electric tramways, the necessity for improvement upon the usual forms of rail joints was constantly impressed upon the Author's attention, and he gave much consideration to the design of a joint device which, while being simple, should effectually meet the practical requirements of electric traction. He believes this has been successfully accomplished in the "Anchor" joint plate (Fig. 11).

This is perhaps hardly the occasion to extol its merits, but the fact that some 50,000 of these joint plates are now in use, is testimony of the favour with which they are regarded by tramway engineers generally. They have long passed the experimental stage and after two years' wear under very heavy traffic, in some of our largest towns, they are found to keep the rail-joints perfectly smooth and without the least sign of looseness. Over forty miles of rails, laid under the Author's direction, have been jointed with these plates, and a large number of corporation and companies' tramways representing a length of some 250 miles of track, have been or are being equipped with them.

The purpose of this joint is not only to form a thoroughly rigid and efficient connection between the rail ends and to make the joint as strong as the rail itself, but also to hold the rails down to the concrete underbed, thus keeping them to gauge and preventing springing, creep, etc.; further, it provides a path for the electric current in case of the failure of bonds, and it has been successfully used without any bonds whatever being fixed

at the joints. When this joint is used fishplates may be considered as an auxiliary and therefore need only be of light bar section having either four or six bolts, and weighing from 40 to 50 lbs. per pair.

Welded Joints.

With the endeavour to make rails practically continuous, several methods of welding have been tried.

These are either mechanical, as the "Falk cast weld"; electrical, as the "Lorain"; or chemical, as the "Goldschmidt."

The "cast weld" joint is formed by pouring a mass of molten iron round the rail ends. It has been largely used abroad, and in this country a number have been laid at Norwich and Coventry. Their cost is approximately about 1*l*. each.

The following information, of practical value when using this joint, is extracted from the 'Street Railway Journal' of March last:—

"Trouble was at first experienced from broken cast weld joints; the work of welding being done in the daytime the heat caused by the molten metal, combined with that of the sun, expanded the rails, when the rails cooled at night some of the welds broke, the openings being over an inch in some cases.

"A plan was then adopted of skipping every fourth joint. Then on some cold night, when maximum contraction had taken place, these remaining joints were cast, result being then quite satisfactory.

"It is well known that when cast iron is subject to a severe tensile strain it is more readily broken than when under a compressive strain. Under the earlier conditions the cast iron in the welds was under tension, due to the contraction of the rails at night, and received a sharp blow from the passing cars. Under the later conditions the iron was almost always under compression."

Further interesting information with reference to this joint may be obtained from the December 1900 issue of the same journal.

Electric welding has not as yet realised the high expectations formed of it. Many thousands of pounds have been expended in trying to perfect this system—the apparatus for use in the street is said to alone cost about 10,000*l*.—but so far it has not been tried in this country.

The Goldschmidt process of chemical welding has been very recently introduced; it is effected by the combustion of a substance termed "thermite," composed of a mixture of aluminium and oxide of iron in the proportions of about 1 to 3, by which a sufficiently high temperature is obtained to effect the welding operation.

Time taken to make a joint is about an hour, and cost stated to be from 25*s.* to 30*s.* each.

This process is said to have been tried with satisfactory results on the Continent, but has not yet been used in England.

The conditions under which tramways are constructed in this country largely militate against the extended use of welded joints.

Welded joints are perhaps least satisfactory on curves, and with the "Falk" joint there is much difficulty in paving close up to the rail due to the mass of metal round the joint. When rails have been welded together there is much difficulty in breaking them up into convenient lengths for removal when track requires renewal, the rails having to be cut, entailing considerable cost.

VIBRATION.

Vibration is exceedingly great with electric traction, and its effects as detrimental to the permanent way. (This fact has recently received much prominence through the published statements of the experience on the Central London Railway.)

In locating a track, beyond conforming to the road surface, but little regard is usually paid to grading or cross levels. Consequent upon the camber of roadway these are often unequal, and on curves it frequently happens that, owing to the exigencies of the situation, the outer rail instead of having superelevation is lower than the inner.

Thus, with cars run at high speeds over necessarily uneven rails laid in winding roadways, vibration and oscillation are naturally set up. An exemplification of this may be witnessed by watching the swaying of the upper deck lamp of an approaching car.

Experiments made with a whitewashed rail surface showed that wheel flanges usually strike with some force the tread and guard alternately; the wider the groove the greater the impact, and with a bad track the damaging effect is of course increased.

Springing, Creeping, etc., of Rails.

When rails are simply laid on a concrete underbed (Fig. 12), the passage at high speeds of heavy rolling loads along their surface tends to set up vertical undulating or wave-like motions, which are carried on from rail to rail; were the latter not embedded in the paving this motion would become very apparent.

In addition to being a cause of rails springing, hog-backing and creeping, this wave-motion, combined with the lateral rocking or tilting motion from vibration, loosens the rail in its surroundings, and frequently has the serious effect of raising the paving next abutting to the rails, sometimes to the extent of an inch or more; and, although the rail may return to its bed, or is forced down by the passage of cars, the side friction on the paving keeps it lifted ofttimes to such an extent as not only to be a menace to vehicular traffic but to come in contact with wheel tyres and life-saving guards.

This phenomenon of rising setts has been but little experienced on horse or cable tramways, due to the cars being much lighter and run at slower speeds, and, being centrally guided, there is little of the enormous vibration experienced from electric cars.

Another effect of the vertical and lateral motions referred to, is to cause a series of concussions between rail base and concrete, which damage the latter and not only loosen the joint fastenings, but cause the rail to ultimately become loose throughout its length.

So essential is it found to counteract this springing, etc., of rails, with its very harmful effects, that various devices are now employed to hold down the rails to the concrete underbed.

The City Engineer of Liverpool, Mr. J. A. Brodie, M. Inst. C.E., than whom perhaps no one in this country has had better experience upon this subject, says he considers it essential that the rails shall be held down, and he has designed an ingenious arrangement for the purpose, which has also the advantage of permitting the rails to be tightened down at any time without necessitating interference with the paving alongside the rail (Fig. 12).

To quote from his specification :—

"This system, consisting of two iron castings and one steel bolt, may be shortly described as follows.

"The lower casting marked C on the drawing is in the form of a bracket or anchor let into the concrete, its top surface being 'flush' with the upper surface of the concrete, and under side of the flange of the rail, the side of the slot in bracket for the bolt being just clear of the rail flange.

"This slot runs the full length of the upper surface of the casting, to allow for sliding the upper casting to work in with the rows of granite setts.

"The upper casting, marked D on the drawing, is hollow and in the form of a stone paving sett, the width being the standard of the setts used in Liverpool; the lower part of this sett has an internal flange which rests on the rail flange and is held by a 1-in. steel bolt, the head being in the slot and the bolt passing up the middle of the cast-iron sett and the nut screwed home in the recess with a box spanner.

"These fastenings are placed on alternate sides of the rail at intervals of about 10 feet. The method of fixing is as follows. After the rail is in position, the bracket is fixed and held up in position by the bolt, and set while the concrete is packed round it, and finally, when the concrete is set and the paving completed, the nut is screwed home."

Sometimes bolts and large washer plates have been used for fastening down, and Mr. Kinnear Clark, in his book on 'Tramways,' speaking of the Liverpool horse tramway system as constructed under Mr. Deacon, says, "Much of the excellence of this system is fairly due to the first-rate material and workmanship and especially to the binding of the rails by bolts to the foundations of concrete."

This method has been followed at Hull, and the success of the track there is admitted to be largely due to the rails being fastened down to the concrete.

GAUGE.

The greatest care is indispensable in laying and maintaining the rails to perfect gauge. If the gauge be strained, the wheel flanges bind against the sides of rail groove, and frictional resistance is greatly augmented, resulting in the flanges being broken or ground away, or their thickness reduced.

The surrounding paving, if of stone, no doubt affords material assistance in keeping rails to gauge, but should only be accepted as an auxiliary.

A very slight inaccuracy of gauge, especially if at points or crossings, will probably mean much expense in repairs to cars, motor gearing, etc., apart from the added wear on track.

An extract from a recent report of the engineer upon the Bolton tramways bears upon this point:—

"The variations existing in gauge are disastrous to the cars, oil grooves are 'hammered' out of place as a result of jolting and twisting, coils of motors are shifted and worn through the insulation, axles have been found to give way through the crystallisation of the steel, wheels have been worn and loosened and the cars themselves wrenched."

The running of tramway cars tends somewhat to spread the gauge. Wood paving is also found to give much trouble from expansion. The tie bars usually used are ofttimes insufficient to resist this. Instances have occurred where rails otherwise well laid and having tie bars at usual intervals have had gauge spread over an inch within three months of being laid, all the tie bars being burst; of course the tracks had to be relaid.

Cutting Rails.

Rails cut at works invariably have a slight vertical taper back from head; care should be taken that this is not excessive. When rails are cut on the site a proper revolving circular saw, as of the Burton-Griffiths type, should be used. Cold sates and hack saws are often used, but they only cut nicks into the surface, after which rail is snapped off, leaving a jagged edge which makes a badly fitting joint, and their use is to be deprecated.

Bolt Holes in Rails.

Fishbolt holes in rails are usually $\frac{1}{4}$ in. larger, and in fishplates $\frac{1}{8}$ in. larger, than the bolts.

Bond holes should be $\frac{1}{16}$ in. less than diameter of bond, being enlarged to proper size on ground immediately before insertion of bond pin.

Holes for fishbolts, bonds and joint plates should be drilled, but slots, $2\frac{1}{2}$ in. by 1 in., for tie-bars may be punched, all burrs being properly cleaned off.

When holes are drilled on the site, a suitable revolving track drill should be used; ratchet drills are sometimes employed, but the work costs more and is less expeditious.

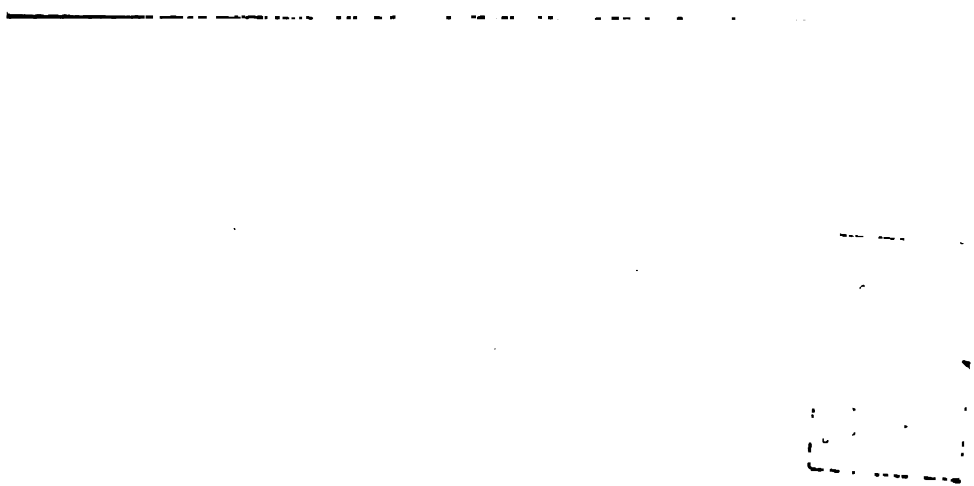


Fig. 16.

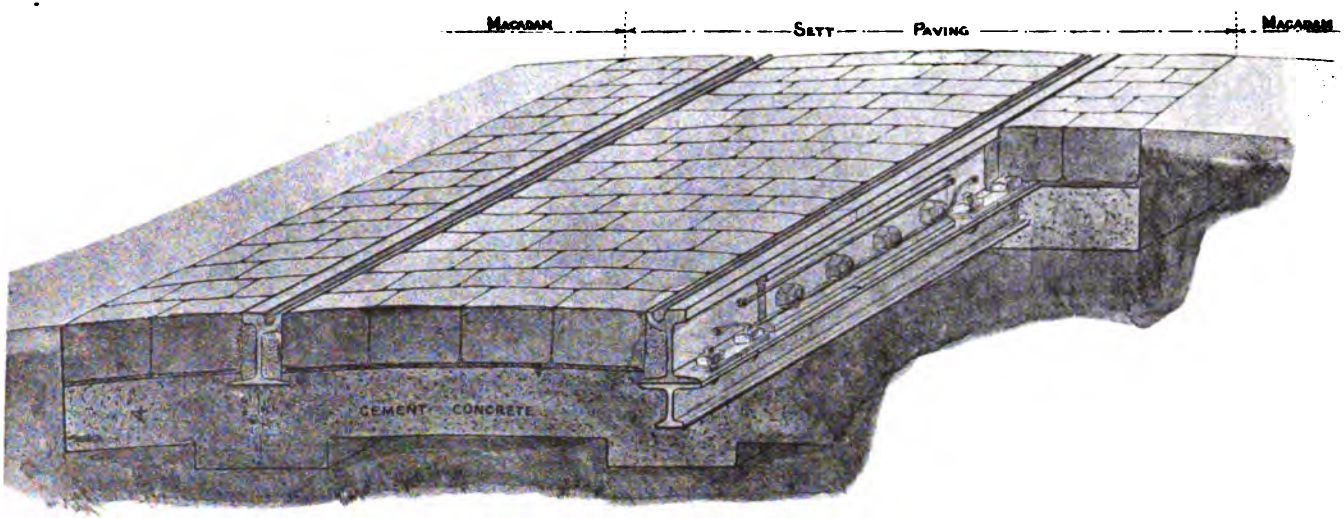


Fig. 16.

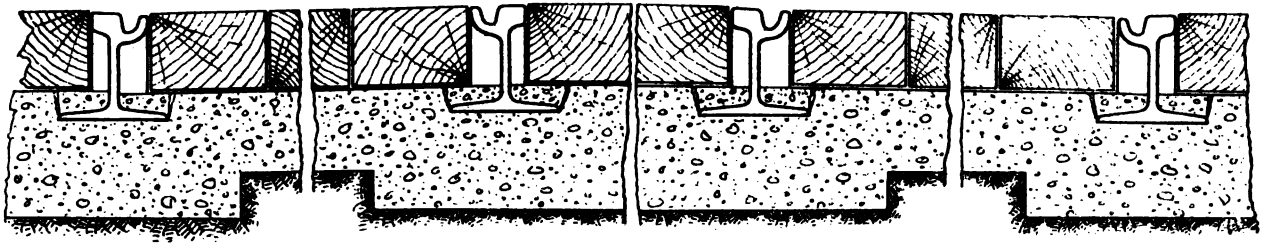


Fig. 17.

CROSS SECTION OF TRACK PAVED WITH TAR MACADAM.

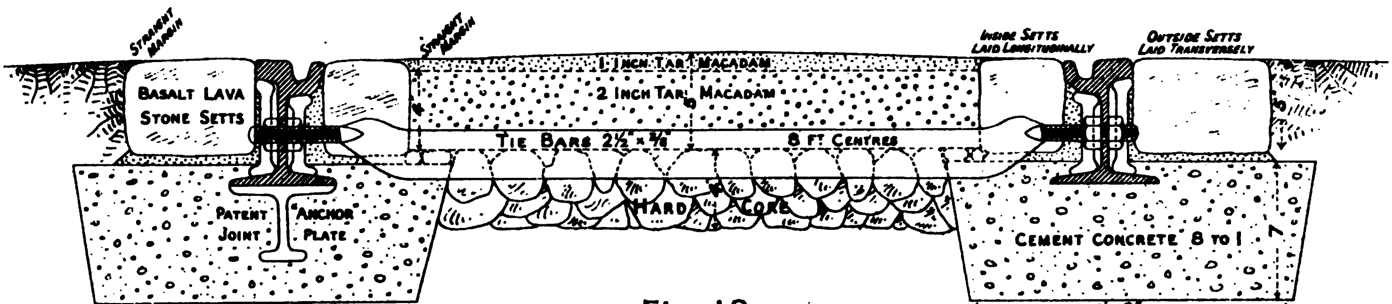


Fig. 18.

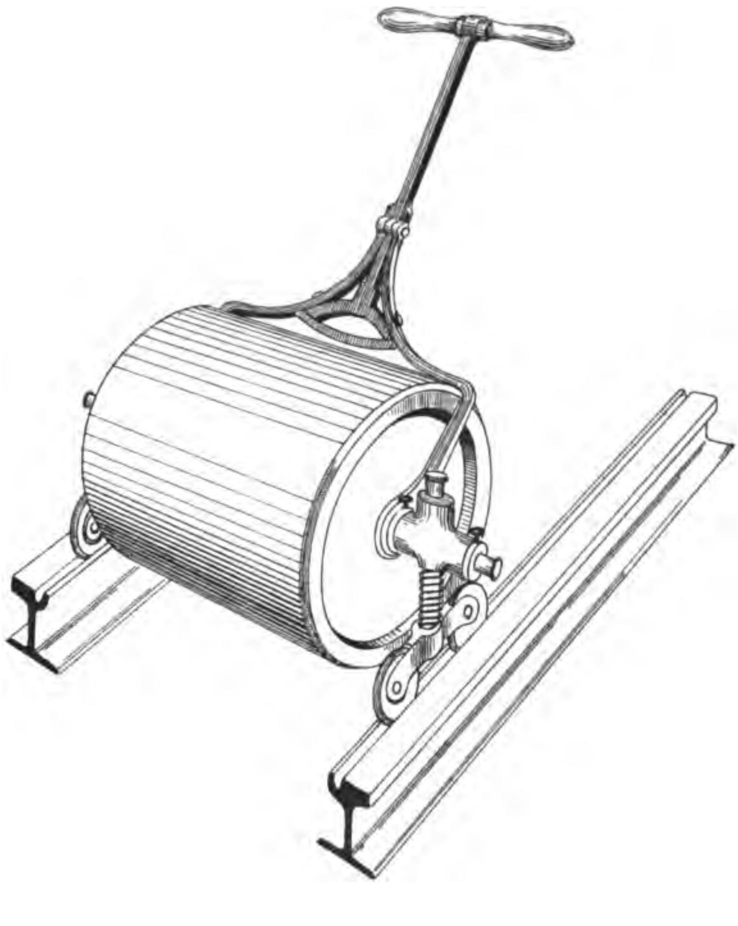


Fig. 19.

Fishplates.

Fishplates should be of somewhat softer and tougher steel than that used for rails, containing not more than—

Carbon	0·15	per cent.
Manganese	·04 to ·06	"
Phosphorus	·10	"
Sulphur	·10	"

They should be rolled true to template and properly fit the rails; the bolt holes should be punched cold, any fishplate showing signs of cracking at holes being rejected.

Tests should be: tensile, 25 to 30 tons per square in.; elastic limit, not less than one-half the ultimate strength; elongation, not less than 25 per cent. measured in 8 in.; bending, flat on itself without fracture.

Fishbolts.

Fishbolts should be 1 in. diameter, having lock-nuts of an effective pattern, otherwise nuts are liable to work loose under constant tremor and vibration of rail. With cup heads, a square shoulder ⅝ in. deep is necessary.

Drain Rails.

Drain rails of cast steel are often laid at the bottom of gradients as a provision for carrying surface water to sewer; while it is necessary to provide for draining the track, drain rails are not to be commended, as the interposition of a different metal leads to unequal wear, and their short length, some 6 or 8 feet, necessitates joints close together.

It is preferable to cut away the rail guard for a short distance and insert a drain-box or special gully.

Tie-Bars.

Tie-bars should be of wrought iron not thicker than ⅝ in., or will cause very wide joints in paving; they should not be less than 2¼ in. deep, when sufficient metal is provided for swaging down to form ⅞-in. threaded end, otherwise end is bent over and a very weak place results.

Tie-bars having one end slotted are preferable to those with both ends threaded, as it is advisable to have as few screw-nuts as possible—they invariably work loose.

The usual distance apart for tie-bars is 8 ft. on the straight, and 6 ft. on curves less than 75 ft. radius, but at joints they are placed about 2 ft. from rail end.

Tie-bars are useful in keeping rails in position, but sole reliance should not be placed in them to hold rails to proper gauge under stress of working.

Curves.

Rails should be bent to the required radius by the use of a hydraulic rail-bender or suitable jim-crow, Fig. 14, of a form to bend by gripping the web and not the head or base; the latter is a very usual but much to be deprecated method, as it tends to distort the rail and to sometimes leave an initial spring which afterwards causes angles to be formed at the joints. Springing in of rails, or bending with hammers, should be prohibited.

An investigation made by the Author into the question of permissible minimum working radii, showed that 30-in. diameter wheels on a 6-ft. 6-in. rigid wheel base with $\frac{3}{4}$-in. flange, running in a $1\frac{1}{16}$-in. rail groove, commence to bind against both sides of groove at 66 ft. radius; this binding increasing as the radius diminishes, both groove and flange suffering.

Much care is necessary in laying out curves of small radii; it has not unfrequently happened that curves have proved unworkable, and have had to be taken up and relaid before cars could be run round. Sweeter running and added life may be obtained by laying curves in the form of a parabola or spiral, with easy transition curves from the straight. Contrary to railway practice, gauge of rails on curves should not be widened.

Rails on curves, being particularly liable to spring from underbed and to spread gauge, should be anchored down intermediately between joints.

In order to provide against fouling through the swing of overhanging ends of single truck cars, it is important that the widths between double line tracks or curves of small radii should be widened out.

Points.

Great care is necessary in the design, manufacture and laying of points; methods thought suitable and sufficient for

horse and steam tramways have not proved successful for electric traction, something much more perfect and of greater stability is demanded.

When a car is deflected from a straight line it should be in such a manner that little inconvenience is experienced; with bad points, or even good ones badly laid, the force of impact is frequently such as to cause a sudden and severe jerk, to the discomfort and possible injury to passengers. Cars are also liable to jump the points, and become derailed, if not accurate. It is very desirable to avoid laying points so as to turn out towards the inside of a curve, which involves an increased angle of deflection with consequent jerk. This impact is very detrimental to the life of the points themselves as well as to the cars and motors.

Facing points are required to work automatically, so as to be always open for the run in. When both arms of points are straight, a length of 7 ft. 6 in. is sufficient, but it is preferable to curve one if not both arms to the required radii when longer points are necessitated.

Special short points with curved arms are usually requisite for turn-outs to car sheds or short crossings.

With curved arms care must be taken that tongues are not made too thin.

The question of which form of point is preferable can only be properly decided in the light of experience, after a study of the circumstances and necessities of the position to be occupied and probable wear.

On open or dummy points or mates (as also on crossings) the groove is frequently raised so that wheel flange may ride thereon, this is to save cutting away of tread by wheel tyre; care must, however, be taken that wheel flange does not receive a sudden impact, therefore groove must be raised gradually.

Before laying, points and crossings should have the core hollows filled in solid with cement or bitumen concrete.

Certain parts of points and crossings being subject to severe shocks wear rapidly; frequently these are made of harder metal, as manganese steel, in a form to be renewable.

The Author has seen points worn out after three months' wear through being of an unsuitable pattern and badly laid; being replaced by suitable points, properly laid, the latter have been in two years and are far from worn out yet.

Crossings.

Crossings built from spliced pieces of the rail used have been much employed, but are now generally giving place to cast crossings.

The angle of crossings should not exceed 1 in 9, while built up crossings should not be used if angle is more acute than 1 in 6, and much care is requisite with these in cutting the rails to proper splays, and also in securely fastening the several parts together, special fish and joint plates being necessary.

Heel pieces of cast steel are occasionally used to fill in the angles at junctions of leads, they should have a chequered top to prevent horses slipping on the metal surface.

Passing-Places on Single Lines.

Distance apart is governed by the frequency and speed of service; four per mile is a usual provision for a ten minute service. Their location depends upon road widths and suitability of surroundings, but they should be sightable from one to the other. Their length is governed by the number of cars to be accommodated; it should at least be sufficient to admit two cars passing clear of those on second track.

The plan of a passing-place usually conforms to one of three methods shown in Fig. 15: No. 1, the diamond; No. 2, the throw-over; and No. 3, the side turnout; but there may be modifications of each of these.

With No. 1 the angles of divergence of both arms of points are equal, both at the run-in and run-out. No. 2 gives a straight run-in—a great desideratum—but a full angle of divergence at the run-out. No. 3 is the least desirable form, as it gives the maximum angle of divergenee both at the run-in and run-out at one end.

The general plan of No. 1 is to be preferred, as it is more symmetrical and offers less interference with road traffic, but the angle of divergence at the run-in is undesirable. The Author has adopted a method, No 4, whereby, while the diamond plan is retained, the advantage of a straight run-in is also secured; this is attained by laying the frog slightly out of the centre, the particular distance being dependent upon the angle of crossing, etc. He has found this method very successful in

avoiding the jerk and jolt frequently experienced when cars pass through points; it is shown in detail in Drawing No. 16.

A survey of the sites of all passing places should be plotted to a large scale and the exact angles and leads laid out thereon, as sweetness of running may be greatly assisted by the judicious use of a suitable angle of crossing. It may happen, especially when a passing-place is situate on a curve, that while an angle of 1 in 4 will be most suitable at one end, 1 in 8 will be best at the other; the great importance of this detail is frequently overlooked.

For those passing-places situate on a straight, a "standard" angle of crossing can be decided upon. The views of engineers as to the best angle to adopt in such cases appear to vary considerably, some using 1 in 4½ while others prefer 1 in 7. The Author has found 1 in 5½ a good angle for town lines, while 1 in 7 is better suited for suburban lines, where the speeds are likely to be faster. Generally speaking, the more obtuse the angle the greater the jerk likely to be experienced by car when turning into or out of a turn-out, while an acute angle means longer leads and consequent increased cost.

Frequently a "standard" angle of crossing has on many lines been made to do duty under all circumstances, whether laid on a straight or on a curve. This practice is not to be commended; it will often be found that by a variation in the angle of crossing, so as to suit the particular position, much easier running may be secured.

The Author has prepared the Table in Appendix to show the proper lengths of leads and other data for the design and construction of diamond passing-places with crossings of various angles. No advantage is gained by extending the length or increasing the radii of curve leads beyond the dimensions here given.

The distance of 7 ft. 9 in. between centres of tracks allows for an overall dimension of car of 6 ft. 6 in., practically a maximum width; and for 1 ft. 3 in. between passing cars, the Board of Trade requirement.

Concrete Foundation.

Concrete for underbed is usually composed of 1 part of cement (it is seldom that lime can be used with advantage) to 6 of aggregate, though occasionally 8 or 9 of aggregate are

used; but so much depends upon its character that it may well happen that 9 to 1 with a good aggregate will produce better concrete than 6 to 1 with an indifferent one. The Author's practice is to use 6 to 1 under the rails, with a further slight addition of cement at each "Anchor" plate, while 8 to 1 is used under paving; where paving is of wood, this is floated over with a layer about an inch thick of 3 to 1.

Depth usually is 6 in. below base of rail, and from 4 in. to 6 in. below paving, Fig. 16. Old macadam is often utilised for the purpose of the aggregate, and there is no objection to this provided it is thoroughly screened and all dirt eliminated; but in wet weather this is difficult, as mud adheres to the stones. Of course concrete should be well mixed and the cement thoroughly incorporated.

In laying concrete one of two methods is usually employed.

The first is: After the excavation has been made, to lay in the concrete to a height sufficient to bring the surface to approximate to a level as near as practicable about 1 in. below base of rail, pegs being previously driven to indicate this. After the concrete is set the platelaying gang lay the rails to their proper positions and levels, supporting them at intervals with thin packings.

When this work is approved, then part of the concreting gang pack in the inch space under base of rail with fine granite or stone chippings and cement, 2 to 1, mixed dry, forcing same into space by means of beater picks. The webs of rails are then parged, the sand bed spread, and paving proceeded with.

The second method is: After the excavating gang have completed their work, for the platelaying gang to lay in the rails to their proper alignment and levels, temporarily supporting them at intervals on concrete bolsters, bricks or wood blocks.

When the platelaying has been approved, the concreting gang throw in the concrete to the requisite level, men being told off with strong spades to make solid the concrete under the rail base, the bolters are then removed and their places filled solid with concrete; the parging and paving are then proceeded with as before.

This, termed the "pudding" method, has several practical advantages over that first described; better work results, because the platelayers, in walking over the concrete underbed while laying the rails, in manner first described, are apt to deposit

thereon particles or even a layer of dirt or clay, which prevents the dry cement packing adhering to the concrete surface. Less cost, inasmuch as one operation suffices to complete the whole of the concreting; and a more perfect bed for rail base is obtained.

Further, it is not practicable under first method to lay the concrete so that its surface shall always be one inch, neither more nor less, below base of rail. With the best work this will vary longitudinally from say 2 in. to perhaps a quarter of an inch or even less, when it is difficult, if not impossible, to force in the dry packing, and if this is too thin there is a danger of it being disintegrated and crushed to powder under the effect of heavy rolling loads.

A further contingency is that, through careless workmanship, the packing may be done at the outer edges and not extend through full width of rail base, thus leaving rail with a hollow bed, probably to be afterwards filled with surface water.

By the first method the concrete surface being finished off one inch below rail means with say a 6½-in. rail a depth from rail surface of 7½ in., which necessitates either laying a second layer of concrete, a very thick sand bed, or unusually deep setts.

By the "pudding" method the surface of concrete can be brought at one operation to whatever level may be desired. Having given extended trial to both, there is no question in the Author's view as to which is the better method.

Packing under the base of rails, especially after the rails have once taken up their bed, is to be strongly deprecated and its necessity avoided in every possible way. To have to resort thereto is a confession that the track is weak and has not been properly constructed.

Packing disturbs the rail in its bed and surroundings, the process of forcing a thin layer of stone chippings between the rail base and the concrete so as to be solid throughout depends upon great care on the part of the workmen employed. Even when the process is properly executed it is more than probable that the chippings are quickly crushed into powder between the hard surfaces of the rail and concrete under the pressure from heavy loaded cars. Such packing also, by lifting the rail base off its bed, always leaves a long wedge-shaped hollow on each side which is a source of mischief from surface water accumulating therein.

Parging.

The hollow on each side of rail web should be plastered or filled with a "parging," composed of one part of cement to four of sand, laid to present a sound vertical surface to pave against.

Sometimes special shaped creosoted wood boards are used instead of cement "paving," and occasionally the paving blocks or stone setts are cut and shaped to fit into web of rail: this is costly but it tends to prevent the blocks lifting.

Paving.

The materials used for tramway paving should be as imperishable as possible. Judged by the periods usually allowed by the Local Government Board for repayment of loans, the life of soft wood on busy roads is estimated at six years, hard wood at ten years, and granite and similar stones at about thirty years.

Granite or other stone setts are most frequently used, of a depth of 5 in. or 6 in., laid about ¼ in. above rail surface, on a sand cushion ¾ in. deep before ramming; with this it is usual to mix dry, a proportion of cement, say 1 to 4, which quickly solidifies. By this practice a firmer bed is obtained and the setts are not so liable to sink under wear, but it makes the paving somewhat more noisy.

Wood paving, on account of its noiseless character, is frequently required to be used in the business parts of a town and opposite places of worship, schools, etc., but there are so many attendant disadvantages that a tramway engineer seldom lays it from choice. It should not in any case be laid on gradients steeper than 1 in 18.

The principal objections against wood are its liability to expansion and contraction, its tendency to rot, its greasiness at times, necessitating sanding, and its unreliability; blocks vary very much in character, one sample will expand considerably while another will contract to a like extent; apparently little care is exercised in selecting trees at maturity, or in seasoning planks, and again blocks may be from heart wood or from outer or sapwood. Great care should be exercised to exclude sappy or shaky blocks.

Wood paving contracts greatly under the effects of extreme cold as well as of excessive dryness. Expansion and contraction

are particularly objectionable on tramways, the first tends to spread the gauge while the latter by opening the joints allows surface water to penetrate to underbed.

Within the Author's experience the expansion of wood paving proved so great on a tramway, only 3-ft. 6-in. gauge, that cars could not be run, the tie-bars were found burst, and the gauge spread over an inch for long lengths of track, which had to be relaid; and he has learnt of several similar cases.

He has also seen soft wood blocks risen $1\frac{1}{2}$ in. above rail surface, and men working with adzes trying to dress off the protuberances—though not very successfully, on account of the grit embedded in the fibres of the wood.

The construction of a tramway makes it peculiarly liable to cause expansion in wood paving. When the whole of a carriage-way is paved with wood, the cement screeding or floating, on which the blocks are laid, usually forms a continuous curve in cross section, thus conducting the surface water to the channels, where any trouble from expansion is made manifest; but in a tramway a series of practically water-tight troughs (Fig. 17) are formed for surface water if admitted to accumulate, soaking the bottom of the wood, the top surface being perhaps at same time subject to great sun heat—conditions which not only cause expansion but are detrimental to the life of the material.

All possible means should be taken to prevent water penetrating to underbed, therefore a clause such as the following from a recent specification is not to be advised:—

"At the rail joints the paving blocks next the outer fish-"plate shall not be pitch grouted until after the lines have been "opened and at work for two months, after which the loose part "of the paving shall be lifted, the fishbolts finally tightened, and "the paving replaced and grouted up."

With these loose joints, open probably for a long period before completion of track, and then for two months after, there would be opportunities for any quantity of water to find admittance to underbed.

Again, rail grooves are systematically watered to liquefy the grit, with open joints much of this water is likely to percolate.

In one or two instances wood blocks have been laid on tramways with expansion joints, but it is questionable whether this is advisable, as such joints allow surface water to pass even easier to underbed.

Wood paving is not permissible with the conduit system, as it has been found that its expansion closes the slot; for this reason its use has been prohibited on the proposed London County Council tramways.

A method which has been tried on some tramways, is to lay creosoted soft wood blocks with a serrated or "hit-and-miss" course of hard wood next abutting on each side of rails. This, however, has not proved an unqualified success. At the present time, on a South London tramway, relaid on this method some three years since, there may be seen humps over an inch in height on each side of the rails, and in wet weather the wood between tracks rises and forms an arch, giving forth a hollow sound under horse traffic.

Where the whole width of carriageway is wood paved, much less trouble is experienced from expansion between the rails, the haunches forming counteracting buttresses.

Tramways usually have paved margins 18 inches in width. When these adjoin macadam it is best to lay the setts with a straight edge, as, with a serrated edge, the macadam cannot be properly rolled into the serrations—these become filled with mud, which, when dry, leaves hollows between the setts, and the latter become rounded, making a noisy road.

Where a wood paved margin abuts upon macadam, it is desirable to lay a single course of stone setts between the wood and macadam to prevent the abrasion of the wood.

Whether grouting should be of bitumen or cement depends upon local circumstances and upon the particular paving material used. Usually bitumen is to be preferred. In either case it should be carefully run so as to solidify the paving and exclude all water soaking through.

Trouble is frequently experienced by cement or bitumen grout getting into rail grooves and adhering to the metal, from which it is difficult to detach, but this may be avoided if the rail head be previously whitewashed.

Tar macadam has, to a limited extent, been used for paving tramways. Examples may be seen at Sheffield, East Ham and Poole; the latter has a length of about 4 miles constructed under the Author's direction, Fig. 18. He is of opinion that it forms a suitable material for suburban or inter-urban tracks on which vehicular traffic is light. Very great care is however necessary in the selection and laying of the materials. It is not desirable

to use less than 1-in. stone for top coating, and much depends upon thorough consolidation ; to ensure this the Author devised, for use on tracks constructed under his direction, a special form of roller (Fig. 19).

When this material is used for tramway paving on a road where there is vehicular traffic, it is requisite to use setts next the rail on each side, as the macadam is of too soft a nature to withstand the "rutting."

Ordinary macadam has been used on a few inter-urban lines with little vehicular traffic, setts being laid next rails. It is not a desirable material, as it has little permanency of wear, and the dust caused through disintegration in dry weather, besides being objectionable to the passengers, is apt to get into the mechanism of car; loose stones, grit and mud also get into rail grooves.

Very great care is necessary in rolling; if surface is left too flat, hollows form for the accumulation of surface water, while if laid with a full barrel, experience has shown that there is a likelihood of the life-saving guard, or fender, catching against loose stones and forcing them into the surface, which may be ploughed up to a serious extent and much damage caused before car is stopped. The fenders or guards are usually only some two or three inches from surface, and project beyond extreme end of overhang of car; when car has only a single truck, the rocking brings the guard almost touching road surface.

Asphalt has not been found suitable for tramway paving; it quickly wears into ruts, and the tremors of rail causes disintegration, which in turn allows moisture to penetrate to concrete bed, and in frosty weather the asphalt is lifted therefrom.

Several other forms of paving have been tried on tramways: among these are Staffordshire blue bricks; "McDougall's blocks," which are made by wood studs being let into blue bricks; "sanitary blocks," made from a mixture of broken stone and bituminous asphalt compressed; and basalt lava setts. The latter—a non-slippery and noiseless natural stone—are coming much into favour, and they appear to possess in a high degree most of the qualifications necessary for a good tramway paving.

The effect of much wheel traffic passing along rails is to cause "guttering" or "rutting" in the adjoining paving, especially when of wood. As a preventive, chilled cast-iron chequer blocks or short pieces of thin rolled joists are sometimes used, but both are costly and become noisy when the alternate wood

blocks wear down; it will be found preferable to insert narrow steel strips, which are cheaper and have proved of equal efficacy.

At Dublin recently it has been held that the usual obligation upon a tramway authority to keep its track in good order, includes sanding the surface—the tramway company being mulcted in heavy damages for accidents caused through horses slipping on the sett paving. So far as the working of an electrically propelled system of tramways is concerned sanding is the reverse of desirable, as much of the grit works into the rail grooves, where its presence, as previously pointed out, is most inimical to the proper working of the line.

It is therefore important that a paving material should be employed which will, without the use of sand, afford a safe foothold under all atmospheric conditions. Whinstones and basalts, or so called granites, are quite inadmissible, and most of the Swedish and Norwegian and some of the Scotch, Leicestershire and other granites become exceedingly slippery and rounded at the arrises under wear.

Wheel Tyres.

It is essential that wheel tyres shall be of a design suited to the rail head. From the use of unsuitable wheel tyres, and especially of flanges, constant friction, binding and undue wear take place, these effects being particularly apparent on curves, and at points, crossings and special work.

The wheels should be pressed upon their axles with absolute accuracy; the general practice leaves much to be desired in this respect. Within the Author's experience much trouble has been experienced from car wheels being inaccurate to gauge, Fig. 20. The wheel gauge should be $\frac{3}{8}$ in. less than the track gauge, and a proper template should always be used to test the accuracy of fixing. By the adoption of this course there would be fewer broken flanges, and the tongues of points would last longer.

Fig. 1 shows a profile of a wheel tyre which the Author would suggest as suitable as a "standard," to conform to the standard rail design previously referred to. The flat end of flange gives strength, and would be found an advantage when flange runs upon dirt or upon the raised groove or liners often used at open points and crossings.

The shape of rail tread and that of wheel tyre should accord—a most important point, too often lost sight of. Frequently the rail tread is horizontal, whereas wheel tyre is invariably coned or bevelled. In these cases, until such time as the wheel tyre has worn away the rail tread to conform to its own profile, the wheel has only a partial bearing and can exercise but little tractive effort or obtain full electric contact. The result is that a liberal use of sand becomes necessary, especially on gradients, which again helps to wear away the rails and tyres, and it sometimes happens, especially with a new track, that so little adhesive effect can be obtained that a car cannot be properly braked when going down a grade or obtain proper adhesion when going up one.

When rail and tyre profiles are not in accord, the rail tread being the softer, wears away the quicker, and by the time a full bearing is reached an appreciable portion of the life of the rail has been lost. The tyres also suffer much, especially when skidded on emergency stops wearing into a number of flats. When rail tread and wheel tyres are each coned, car axles are maintained at right angles, cars are kept better centred on track, and it is possible for wheels to travel at different rates without slipping, as is necessary when passing round curves. With 30-in. wheels travelling for a quarter of a circle of 50 ft. radius, the outer wheel has to travel 7 ft. 4¾ in. further than inner wheel.

Life of Rails.

From the limited experience in this country of the effects of wear, etc., from electric traction, it is difficult to determine with any degree of definiteness what may be generally calculated upon as a fair average period for rails to last before requiring renewal.

Many factors enter into the question. As much depends upon the suitability of profile and of the chemical constituents of the rails and their accessories, and the manner in which they are laid, as upon the amount of traffic they have to carry; it particularly centres itself round the life of the joints, these forming the weak link in the whole chain.

The Author has for some years given attention to this matter, and he has taken a number of measurements and rubbings of worn-out rails, some of which are shown on Fig. 21. Space does not permit this question being dealt with at length,

but, in his opinion, the rails laid on tramways under electric traction in this country will probably be found to have an average life as under:

Where frequency of car service is five minutes or less, and vehicular traffic heavy.	Eight to twelve years on straight line, with gradients flatter than 1 in 40.
Ditto, ditto	Six to ten years on straight lines, but gradients steeper than 1 in 40.
Ditto, ditto	Two to six years on curves less than 1 chain radius.
Where car service is less frequent than five minutes, and vehicular traffic light.	Ten to fifteen years on straight lines with gradients flatter than 1 in 40.
Ditto, ditto	Seven to twelve years on straight lines with gradients steeper than 1 in 40.
Ditto, ditto	Four to eight years on curves less than 1 chain radius.

Local and special circumstances may either lessen or prolong life beyond these periods. The use of a thoroughly efficient joint will probably add at least 50 per cent., and much additional life may be gained by careful attention to engineering details.

Herr K. Berger, engineer of the Essen tramways, at the recent Paris Congress of the International Tramways Association, showed a 90-lb. rail (Fig. 22), having a half lap or raised fishplate joint, which he stated was worn out and had to be renewed after three years' wear under ordinary traffic and circumstances.

On some tramways the wear on curves of small radii is found so excessive that renewal of rails becomes necessary about every twelve months, in some cases even less.

The Author would be glad, at any time, to receive rubbings or measured drawings of worn tramway rails, with particulars as to number of years in use, whether on curves, gradients, etc., and such other data as may be necessary to form a criterion as to comparative life. This applies to rails worn out under horse or steam traction as well as to those worn out under electric traction. He would then hope to collate such information for the benefit of this Association.

Cost of Construction per Mile of Single Track 3-ft. 6-in. Gauge, Sett Paved.

Many miles of tramways have been constructed, in various parts of the country, by the employment of direct labour under

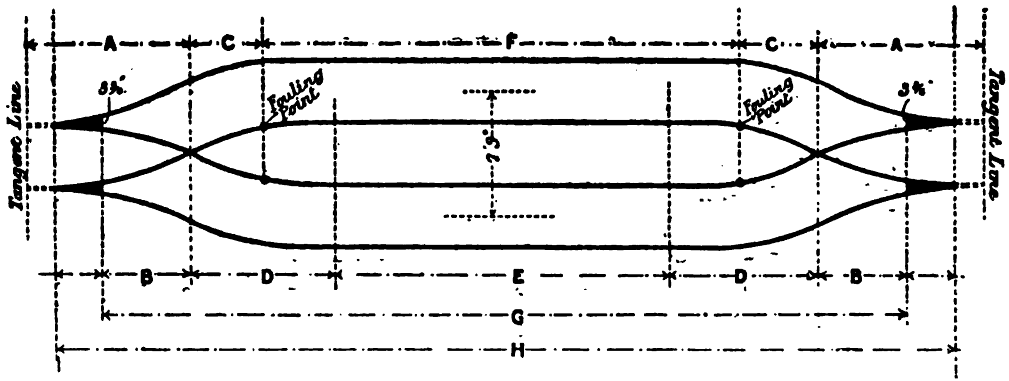
the Author's direction, and the following has proved a reliable estimate of average cost of 1 mile of single track, 3-ft. 6-in. gauge, exclusive of passing-places, no allowance being made for waste, etc.

Cost of construction varies according to design, current prices of materials, local circumstances, etc.

Quantity.		£	s.	d.
145 tons in	No. 235 steel girder rails, 45 ft. long, 92 lbs. per yard, at 6l. 15s. per ton	978	15	0
235 pairs „	40 lbs. fishplates, at 7l. 15s. per ton ..	32	11	0
940 No. „	2 lbs. fishbolts and nuts, at 16l. per ton	13	12	0
235 No. „	patent "Anchor" joints, complete with fastenings, at 11s. each	129	5	0
725 No. „	14 lbs. tie-bars, notched, at 7l. per ton	31	14	0
935 No. „	22½-in. copper joint bonds, 4/0, at 2s. 6d. each	29	7	6
235 No. „	27½-in. ditto, at 2s. 9d. each	32	6	3
18 No. „	45-in. copper cross bonds, 4/0, at 4s. each	3	12	0
488 No. „	Bonds fixed and painted, at 9d. each ..	18	6	0
7040 lin. yds.	Cement parging to rails, at 3d. per lineal yard	88	0	0
1760 „	Laying permanent way, complete, at 2s. 6d. per lineal yard	220	0	0
1380 cub. yds.	Excavation, at 3s. 6d. per cubic yard ..	241	10	0
760 „	6-inch Portland cement concrete, 6 to 1, at 18s. per cubic yard	684	0	0
920 tons	Granite setts, 5 inches deep, at 32s. 6d. per ton	1495	0	0
50 „	Pitch, at 38s. per ton	95	0	0
8 „	Creosote oil, at 82s. per ton	32	16	0
3360 sup. yds.	Sand and cement bed for setts, at 9d. per sup. yd.	126	0	0
3360 „	Paving, ramming and covering off, at 1s. per sup. yd.	168	0	0
3360 „	Racking and grouting, labour only, at 6d. per sup. yd.	84	0	0
1760 lin. yds.	Making good to outside edge of margins, at 1s. per lineal yard	88	0	0
1760 „	Watching and lighting	132	0	0
1140 tons	Carting materials to site, at 2s. 6d. per ton	142	10	0
800 cub. yds.	Removing surplus soil and materials, at 2s. per cubic yd.	80	0	0
Provisions:—				
Possible interference with man-holes, lamp-holes, etc. ..		50	0	0
„ „	with gas or water mains and services	100	0	0
		5096	4	0

On basis of similar prices, etc., add 475l. if track is 4′ 8½″ gauge.

NOTE.—No allowance is made for use of plant, contractor's profit or contingencies.



PASSING-PLACES. 3-FEET 6-INCH GAUGE.

(1) *Diamond turn-outs.* (2) *Centres between tracks, 7 feet 9 inches.* (3) *Fouling point, 3 feet.*

Angle of Crossing in Units.	Angle of Crossing in Degrees.	Length of Curve Lead, i.e. Distance from Tangent Point to Frog.	Length of Crossing Lead, i.e. Distance from Heel of Points to Frog of Crossing.	Radius of Curve Lead.	Distance from Centre of Frog to Fouling Point.	Distance from Centre of Frog to Straight.	Length of Straight.	Length between Fouling Points.	Length of P.P from Heel to Heel of Points (open 3¾").	Approximate Total Length of Passing Place. Nose to Nose of Points.
	deg. min.	A ft. in.	B * ft. in.	ft. in.	C ft. in.	D ft. in.	E ft. in.	F ft. in.	G * ft. in.	H ft. in.
1 in 3	18 54	21 0	14 10¾	126 0	11 8	25 6	62 4	90 0	143 2	149 0
1 „ 3½	16 16	24 6	17 4½	172 0	13 8	29 9	57 9	90 0	152 0	158 0
1 „ 4	14 14	28 0	19 10¼	224 0	15 7	34 0	53 3	90 0	160 11	168 0
1 „ 4½	12 40	31 6	22 4	284 0	17 6	38 3	48 8	90 0	169 9	177 0
1 „ 5	11 26	35 0	24 9¼	350 0	19 6	42 6	44 0	90 0	178 8	187 0
1 „ 5½	10 24	38 6	27 3½	424 0	21 6	46 9	39 5	90 0	187 6	196 0
1 „ 6	9 32	42 0	29 9	504 0	23 5	51 0	34 10	90 0	196 3	206 0
1 „ 6½	8 48	45 6	32 3	592 0	25 3	55 3	30 1	90 0	205 0	215 0
1 „ 7	8 10	49 0	34 8¼	686 0	27 3	59 6	25 5	90 0	213 10	224 0
1 „ 7½	7 38	52 6	37 2½	788 0	29 2	63 9	20 10	90 0	222 9	233 0
1 „ 8	7 10	56 0	39 8	896 0	31 1	68 0	16 3	90 0	231 6	242 0
1 „ 8½	6 44	59 6	42 2	1012 0	33 1	72 3	11 8	90 0	240 6	252 0
1 „ 9	6 22	63 0	44 8	1134 0	35 0	76 6	7 0	90 0	249 4	261 0

NOTE.—In columns marked * the dimensions are given from heel of switch-point, the opening of which is taken at 3¾ inches.

PASSING-PLACES. 4-FEET 8½-INCH GAUGE.

(1) *Diamond turnouts.* (2) *Centres between tracks, 7 feet 9 inches.* (3) *Fouling point, 1 foot 10 inches.*

Angle of Crossing in Units.	Angle of Crossing in Degrees.	Length of Curve Lead, i.e. Distance from Tangent Point to Frog.	Length of Crossing Lead, i.e. Distance from Heel of Points to Frog of Crossing.	Radius of Curve Lead.	Distance from Centre of Frog to Fouling Point.	Distance from Centre of Frog to straight.	Length of Straight.	Length between Fouling Points.	Length of P.P. from Heel of Points to Heel of Points (open 3⅞").	Approximate Total Length of Passing Place, Nose to Nose of Points.
		A	B *		C	D	E	F	G *	H
	deg. min.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in
1 in 3	18 54	28 8½	20 7	169 0	10 0	18 3	73 8	90 0	151 3	157 0
1 „ 3½	16 16	32 11½	24 0¾	232 0	11 9	21 3½	70 11	90 0	161 8	168 0
1 „ 4	14 14	37 8	27 6	302 0	13 6	24 4	68 3	90 0	171 11	179 0
1 „ 4½	12 40	42 5	30 11½	382 0	15 2	27 4½	65 6	90 0	182 3	190 0
1 „ 5	11 26	47 1½	34 5	470 0	16 10	30 5	62 10	90 0	192 9	202 0
1 „ 5½	10 24	51 10	37 10	570 0	18 6	33 5½	60 3	90 0	202 9	212 0
1 „ 6	9 32	56 6	41 3	678 0	20 3	36 6	57 6	90 0	213 0	222 0
1 „ 6½	8 48	61 3	44 8½	796 0	21 11	39 6½	54 10	90 0	223 4	232 0
1 „ 7	8 10	65 11½	48 3	923 0	23 6	42 7	52 2	90 0	233 6	243 0
1 „ 7½	7 38	70 8	51 7	1058 0	25 4	45 7½	49 6	90 0	243 10	253 0
1 „ 8	7 10	75 4½	55 0	1204 0	27 0	48 8	46 9	90 0	254 0	264 0
1 „ 8½	6 44	80 1	58 6	1360 0	28 9	51 8½	44 1	90 0	264 6	276 0
1 „ 9	6 22	84 10	61 11	1524 0	30 6	54 9	41 4	90 0	274 9	286 0

NOTE.—In columns marked * the dimensions are given from heel of switch-point, the opening of which is taken at 3⅞ inches.

ANALYTICAL PARTICULARS OF SOME OF THE MOST USED IN THE

	Works Section Number.	Weight in lbs. per Yard.	Total Height.	Width of Base.	Width of Groove.	Width of Tread.	Width of Guard.	Total Width of Head.
			in.	in.	in.	in.	in.	in.
WALTER SCOTT, LTD., LEEDS STEEL WORKS.	1	108	7	$7\frac{1}{2}$	$\frac{13}{16}$	$1\frac{3}{4}$	$\frac{9}{16}$	$3\frac{1}{8}$
	2	98	7	7	$\frac{29}{32}$	$1\frac{9}{16}$	$\frac{5}{8}$	$3\frac{3}{32}$
	4	92	6	7	$\frac{7}{8}$	$1\frac{1}{2}$	$\frac{5}{8}$	3
	5	98	7	7	1	$1\frac{5}{8}$	$\frac{5}{8}$	$3\frac{1}{4}$
	6	100	7	7	$\frac{15}{16}$	$1\frac{5}{8}$	$\frac{5}{8}$	$3\frac{3}{16}$
	7	$92\frac{1}{2}$	6	7	1	$1\frac{9}{16}$	$\frac{17}{32}$	$3\frac{3}{32}$
	9	105	7	$7\frac{1}{2}$	$\frac{15}{16}$	$1\frac{11}{16}$	$\frac{7}{16}$	$3\frac{1}{32}$
	10*a*	98	7	7	$1\frac{3}{16}$	$2\frac{1}{32}$	$\frac{5}{8}$	$3\frac{27}{32}$
	10*b*	105	7	7	$1\frac{3}{16}$	$2\frac{1}{32}$	$1\frac{1}{16}$	$4\frac{3}{32}$
	11	$95\frac{1}{2}$	7	7	$\frac{31}{32}$	$2\frac{3}{32}$	$\frac{31}{32}$	$3\frac{13}{32}$
	12	98	7	7	$\frac{15}{16}$	$1\frac{17}{32}$	$\frac{9}{16}$	$3\frac{1}{32}$
	13*a*	86	6	6	$1\frac{1}{8}$	$1\frac{3}{4}$	$\frac{1}{2}$	$3\frac{5}{8}$
	14	98	7	7	1	$2\frac{1}{32}$	$\frac{5}{8}$	$3\frac{21}{32}$
	15	102	7	7	$1\frac{1}{8}$	2	$\frac{5}{8}$	$3\frac{3}{4}$
	16	95	$4\frac{1}{2}$	5	$1\frac{3}{16}$	$2\frac{5}{8}$	$\frac{31}{32}$	$4\frac{7}{32}$
	17	$95\frac{1}{2}$	7	7	1	$2\frac{1}{16}$	$\frac{31}{32}$	$3\frac{13}{32}$
	18	107	7	7	$1\frac{1}{8}$	$2\frac{1}{32}$	$\frac{1}{2}$	$3\frac{21}{32}$
	19*a*	94	7	7	$1\frac{1}{8}$	2	$\frac{17}{32}$	$3\frac{21}{32}$
	20	92	7	7	1	$1\frac{3}{4}$	$\frac{5}{8}$	$3\frac{5}{8}$
	22*	91	$6\frac{1}{2}$	$6\frac{1}{2}$	$1\frac{1}{16}$	$1\frac{29}{32}$	$\frac{19}{32}$	$3\frac{9}{16}$
	23*	90	$6\frac{1}{2}$	$5\frac{3}{4}$	$1\frac{1}{16}$	$1\frac{7}{8}$	$\frac{5}{8}$	$3\frac{9}{16}$
LORAIN CO., AMERICA.	325	83	$6\frac{5}{8}$	6	$1\frac{3}{16}$	$1\frac{13}{16}$	$\frac{1}{2}$	$3\frac{1}{2}$
	329	86	6	6	1	$2\frac{1}{8}$	$\frac{5}{8}$	$3\frac{3}{4}$
	347	103	7	6	$1\frac{1}{4}$	$1\frac{19}{32}$	1	$4\frac{1}{4}$
	348*	90	$6\frac{1}{2}$	$5\frac{3}{4}$	$1\frac{1}{16}$	$1\frac{7}{8}$	$\frac{5}{8}$	$3\frac{9}{16}$
	349	92	$6\frac{1}{2}$	$5\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{7}{8}$	$\frac{7}{8}$ for curves	$3\frac{1}{8}$
	350	91	7	6	$1\frac{1}{4}$	$2\frac{1}{4}$	$\frac{7}{16}$	$3\frac{15}{16}$
	360	93	7	$6\frac{1}{2}$	$\frac{61}{64}$	$2\frac{3}{64}$	$\frac{11}{16}$	$3\frac{11}{16}$
	365	98	7	$6\frac{1}{2}$	$1\frac{1}{4}$	2	$\frac{5}{8}$	$3\frac{7}{8}$
	366	103	7	$6\frac{1}{2}$	$1\frac{1}{4}$	2	1	$4\frac{1}{4}$
DICK KERR & CO., LTD., PHŒNIX WORKS, GERMANY.	70	83	6	6	$1\frac{1}{8}$	$2\frac{1}{8}$	$\frac{5}{8}$	$3\frac{7}{8}$
	75	87	$6\frac{1}{2}$	6	$\frac{15}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$3\frac{5}{16}$
	78	96	7	7	$1\frac{1}{8}$	$2\frac{1}{8}$	$\frac{1}{2}$	$3\frac{3}{4}$
	91	101	7	7	1	2	$\frac{9}{16}$	$3\frac{9}{16}$
	92	100	$6\frac{1}{4}$	7	$1\frac{3}{16}$	2	$\frac{11}{16}$	$3\frac{3}{8}$

* Nos. 23 Leeds, 348 Lorain, and 494 Barrow, are of the same section

RECENT SECTIONS OF GIRDER TRAMWAY RAILS UNITED KINGDOM.

Depth of Groove.	Depth of Head Outside.	Thickness of Web.	Centre of Web from Gauge Line.	Whether Head is Flat or Coned.	Distance of Guard below Top of Tread.	Where Used.
in.	in.	in.	in.		in.	
7/8	1 5/8	17/32	3/16	Coned	1/8	Wigan.
7/8	1 1/8	1/2	..	Flat	..	Huddersfield.
7/8	1 9/16	7/16	..	,,	..	Blackpool.
29/32	1 5/8	1/2	..	,,	3/32	Birkenhead, St. Helens.
1	1 5/8	15/32	1/8	,,	1/8	Leeds, Halifax, Salford.
15/16	1 3/16	15/32	1/16	,,	..	Bristol, London United, Middlesbrough.
1	1 7/16	1/2	5/32	Coned	3/32	Bradford.
1 1/4	1 1/16	3/8	15/32	Flat	..	Glasgow.
1 1/4	1 1/16	3/8	15/32	,,	..	Glasgow, Bolton, Farnworth.
31/32	1 1/16	3/8	7/16	Coned	3/16	St. Helens, Liverpool, Halifax, Darwen, Bolton, Bootle.
15/16	1 1/8	1/2	..	Flat	3/32	Manchester.
1	1 1/2	15/32	1/4	,,	..	Southampton, Warrington.
1	1 1/16	3/8	7/16	,,	..	Aberdeen, Farnworth.
1 1/8	1 1/8	7/16	3/16	Coned	1/8	Salford, Rochdale.
1 7/32	15/16	7/16	15/16	,,	1/16	Blackpool.
1	1	7/16	3/8	,,	3/16	Croydon.
1 1/8	1 1/8	1/2	1/4	Flat	..	Nottingham.
1 1/8	1	15/32	3/32	,,	1/8	Stockport.
1	1 1/8	7/16	5/16	Coned	3/32	Plymouth.
1 1/16	1	15/32	1/2	,,	1/8	Wolverhampton.
1 1/16	1	7/16	1/8	,,	1/8	Dudley and Wolverhampton.
1	1 3/32	3/8	3/16	Coned	5/32	Dublin, Cork, Margate, Cheltenham.
1	13/16	13/32	3/32	Flat	..	Swansea, Aberdeen.
1 1/4	1 1/16	7/16	13/32	,,	..	Glasgow, Liverpool, Manchester, Newcastle, Birkenhead.
1 1/16 1 1/16	1 1	7/16 7/16	15/32 1/2	Coned ,,	1/8 1/8 above	Gateshead, Greenock, Grimsby, Tynemouth, Middleton, Dudley, Devonport, Ayr, Blackburn, Dundee, Southend, Plymouth, Stourbridge, Ilkeston.
1 1/16	25/32	13/32	3/16	Flat	1/4	Liverpool.
1 1/16	1	3/8	23/64	Coned	3/16	Halifax, Darwen, Dundee.
1 1/4	1 3/32	3/8	13/32	Flat	..	Glasgow.
1 1/4	1 3/32	3/8	15/32	,,	..	Glasgow.
1	1	3/8	7/16	Flat	1/8	Carlisle.
7/8	1 3/16	7/16	1/8	,,	..	Potteries.
1 1/16	1 1/8	3/8	7/16	Coned	3/16	Dublin.
1	1 3/16	7/16	7/16	,,	3/16	Newcastle-on-Tyne.
1 1/4	1 1/2	7/16	7/16	Flat	..	Cardiff.

(designed by the Author); and No. 22 Leeds is practically similar.

ANALYTICAL PARTICULARS OF SOME OF THE MOST
USED IN THE

	Works Section Number.	Weight in lbs. per Yard.	Total Height.	Width of Base.	Width of Groove.	Width of Tread.	Width of Guard.	Total Width of Head.
			in.	in.	in.	in.	in.	in.
BARROW HÆMATITE STEEL CO., BARROW-IN-FURNESS.	216a	98	6	7	13/16	1 1/2	5/8	3
	217	92	7	7	15/16	1 7/16	11/16	3
	233	103	7	7 1/2	1 1/16	1 5/8	7/16	3
	275	106	7	7	1 1/4	1 1/2	1/2	3 1/8
	354	108	7	7 1/2	7/8	1 5/8	1/2	3 1/8
	398	92	7	7	1	1 5/8	1/2	2 7/8
	407	89	6 1/2	6 1/2	1 1/8	1 5/8	5/8	3 3/8
	411	98	7	7	1	1 7/16	9/16	2 7/8
	415	88	6	7	1	1 11/16	3/8	3 1/8
	423	83	6 1/2	6	1 3/16	1 9/16	7/16	3 1/8
	439	100	6 3/4	6 1/2	1 1/8	1 3/4	3/16	3 1/4
	455a	98	7	7	1	2	9/16	3 1/2
	482	83	6	6	1 1/8	1 7/8	1/2	3 7/16
	493	95	7	7	1 1/16	2	9/16	3 5/8
	494a*	90	6 1/2	5 3/4	1 1/16	1 7/8	5/8	3 9/16
	494b	92	6 1/2	5 3/4	1 1/8	1 7/8	7/8 for curves.	3 1/8
	496	100	7	7	1 1/8	1 3/4	5/8	3 1/4
	503	98	7	7	1 1/8	2	5/8	3 5/8
	505	98	7	7	1 1/8	2	5/8	3 11/16
	508a	102	7	7	1 1/8	2	9/16	3 5/8
	509a	92 1/2	6	7	1	1 3/4	1/2	3 1/4
	510a	100	7	7	1 1/8	2	5/8	3 3/4
BOLCKOW, VAUGHAN & CO., LTD., MIDDLESBROUGH.	1	92 1/2	6	7	1	1 9/16	17/32	3 3/32
	2	100	7	7	1 1/8	2	5/8	3 3/4
	3	107	7	7	15/16	1 7/8	9/16	3 5/8
	4	102	7	7	1 3/16	2 1/32	21/32	3 7/8
	5	100	7	7	1	2	9/16	3 9/16
	6	101	6	7	1	1 7/8	5/8	3 1/2
SOCIÉTÉ ANGLEUR, BELGIUM.	9	94 1/2	7 7/8	5 1/2	1 1/4	1 3/4	1/2	3 1/8
	10	85 1/2	5 29/32	5 29/32	1 1/4	1 7/8	13/32	3 13/16
	11	86	6	6	1 1/4	2 3/8	7/16	3 5/8
	12	94	6 5/16	5 1/2	1 3/16	2	1	4 5/32
	13	94	6	7	1	1 3/4	1/2	3 1/4
	14	94	6	7	1	1 1/8	1 1/8	3 1/4
	15	84	6	6	1 3/16	1 3/4	1/2	3 3/8
	18	84	7	5 1/2	1 3/16	1 7/8	11/16	3 3/4

* Nos. 23 Leeds 348 Lorain, and 494 Barrow, are of the same section

RECENT SECTIONS OF GIRDER TRAMWAY RAILS
UNITED KINGDOM—*continued.*

Depth of Groove.	Depth of Head Outside.	Thickness of Web.	Centre of Web from Gauge Line.	Whether Head is Flat or Coned.	Distance of Guard below Top of Tread.	Where Used.
in.	in.	in.	in.		in.	
$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{7}{16}$	..	Flat	..	Plymouth, Accrington.
$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	..	"	..	London, Manchester, Birmingham.
$\frac{11}{16}$	1	$\frac{1}{2}$	..	"	..	Bradford, Huddersfield.
$\frac{11}{16}$	$1\frac{3}{16}$	$\frac{1}{2}$	..	"	..	Glasgow.
$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{5}{16}$	"	..	Sheffield, Bradford, Wigan.
$\frac{3}{4}$	$1\frac{1}{16}$	$\frac{7}{16}$	$\frac{1}{8}$	"	$\frac{1}{8}$	Newport.
$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{15}{32}$	..	"	..	Glasgow.
$\frac{13}{16}$	$1\frac{1}{4}$	$\frac{1}{2}$	..	"	..	St. Helens.
1	$1\frac{1}{4}$	$\frac{7}{16}$	$\frac{1}{16}$	"	..	London United, Bristol Dublin United.
$\frac{13}{16}$	1	$\frac{7}{16}$	..	"	..	Edinburgh.
$1\frac{1}{16}$	$1\frac{5}{8}$	$\frac{1}{2}$	$\frac{1}{16}$	"	..	Glasgow.
1	1	$\frac{7}{16}$	$\frac{11}{32}$	"	..	Blackpool.
$\frac{15}{16}$	$1\frac{1}{16}$	$\frac{13}{32}$	$\frac{5}{16}$	"	..	Perth, Preston, Blackpool and Fleetwood.
$\frac{7}{8}$	1	$\frac{3}{8}$	$\frac{7}{16}$	"	$\frac{1}{8}$	Liverpool, St. Helens, Bolton.
$1\frac{1}{16}$	1	$\frac{7}{16}$	$\frac{1}{2}$	Coned	$\frac{1}{8}$	B. E. T. Co., Devonport, Newport, Southend, Hartlepool, Poole, Merthyr, Stourbridge, Dudley.
$1\frac{1}{16}$	1	$\frac{7}{16}$	$\frac{1}{2}$	"	$\frac{1}{8}$ above	
$1\frac{1}{8}$	1	$\frac{1}{2}$	..	Flat	$\frac{1}{8}$	Oldham.
$1\frac{1}{16}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{11}{32}$	"	..	Huddersfield.
$1\frac{1}{4}$	1	$\frac{7}{16}$	$\frac{15}{32}$	"	..	Wallasey.
1	1	$\frac{1}{2}$	..	"	..	Burnley.
$1\frac{1}{8}$	$1\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{32}$	"	$\frac{5}{16}$	Chatham.
$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{3}{16}$	"	$\frac{5}{16}$	Manchester.
$\frac{15}{16}$	$1\frac{5}{16}$	$\frac{15}{32}$	$\frac{1}{16}$	Flat	..	London United, Bristol, Middlesbrough.
$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{5}{16}$	"	$\frac{1}{8}$	Manchester.
$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$	"	..	Nottingham.
$1\frac{1}{4}$	$1\frac{1}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	"	..	Glasgow.
$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{1}{4}$	"	$\frac{1}{8}$	Birkenhead.
$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{9}{16}$	..	"	..	Brighton.
$1\frac{3}{16}$	1	$\frac{13}{32}$	$\frac{3}{8}$	Flat	..	
$1\frac{3}{16}$	$\frac{5}{8}$	$\frac{13}{32}$	..	Coned	$\frac{5}{64}$	
$1\frac{3}{16}$	$1\frac{1}{8}$	$\frac{13}{32}$	$\frac{3}{8}$	Flat	..	
$1\frac{1}{2}$	$\frac{7}{8}$	$\frac{13}{32}$	$\frac{1}{4}$	"	$\frac{5}{64}$	
$1\frac{1}{16}$	$1\frac{1}{4}$	$\frac{7}{16}$	$\frac{3}{16}$	"	..	Great Crosby.
$1\frac{1}{16}$	$1\frac{1}{4}$	$\frac{7}{16}$	Centre groove.	"	..	Hull, Doncaster.
$1\frac{1}{8}$	1	$\frac{13}{32}$	$\frac{3}{8}$	"	..	Dudley.
$1\frac{1}{8}$	$\frac{3}{4}$	$\frac{13}{32}$	..	"	$\frac{5}{64}$	

(designed by the Author); and No. 22 Leeds is practically similar.

DISCUSSION.

Mr. A. D. Greatorex: I do not intend to discuss the paper, but rise to propose a hearty vote of thanks to Mr. Smith for the extremely useful paper he has given us this morning. It will be useful to every Member of this Association, and more particularly to those of us who have tramways to lay down. It is a paper which will amply repay all for the time taken in carefully studying it before designing any tramways we have to construct. I am sure we are deeply indebted to Mr. Smith for the patience and time he has taken in writing this most valuable paper, and I should like if possible that some of the illustrations which we see on the walls of this room should be reduced down and included in the Proceedings. Without taking up your time I propose a very hearty vote of thanks to Mr. Smith for his paper.

Mr. A. E. Collins: I desire to second the vote of thanks to Mr. Howard Smith, and to endorse his suggestion that this Association should be represented before the Standards Committee. I think we are sufficiently interested in gas and water mains, in addition to tramways, to justify us in bringing our views, as to the necessity for standardising gas and water pipes, before this Committee. I am sorry Mr. Howard Smith was not able to give a little more time to the question of joints for tramway rails. It is a subject to which he has given much study, and in which he has effected a considerable improvement in the invention of the anchor joint. With reference to the paving of tramways, and the difficulties which certain corporations have met, I am convinced that if they had laid the same setts as I have been recently laying in Norwich, they, including the public corporation to which reference is made in the paper, would have avoided their trouble. It is an absolutely non-slippery sett, that is, basalt lava. Where on gradients, my corporation will not now have any other stone sett laid.

Mr. T. H. Yabbicom: I should like to ask a question with regard to the use of guard rails. There are times when we are obliged to have curves on a sharper radius than 50 feet. I know places in Bristol where we have curves of 40 feet, and round these curves a raised guard rail has been placed of 1 inch or 1⅛ inch above the surface of the street. That is very

objectionable, but I regret to say that the Board of Trade Inspector when he came down to view the line sanctioned this raised guard rail on account of the greater safety to the tramway working. I would like to ask Mr. Smith whether he has had any experience of a raised guard rail of this character. I will turn now to the question of wood paving. I notice that Mr. Smith says, "Wood paving should not in any case be laid on gradients steeper than 1 in 18." I have used wood for years past on considerably steeper gradients than that, and very successfully, and I see no reason to alter my views. Mr. Smith also says, "A method which has been tried on some tramways is to lay creosoted soft wood blocks with a serrated or hit-and-miss course of hard wood next abutting on each side of rails. This, however, has not proved an unqualified success." I agree that that is a very objectionable practice on account of the different wearing capabilities of the two kinds of wood. Then further on Mr. Smith says, "Where a wood-paved margin abuts upon macadam, it is desirable to lay a single course of stone setts between the wood and macadam." I have tried this combination, but cannot say that I have found it desirable, as you get four different materials—steel, wood, granite and macadam. All these materials have a varying amount of wear, and the result generally is that the granite has stood up above the macadam and the wood and formed a very bumpy road. Mr. Smith further says, "Ordinary macadam has been used on a few inter-urban lines with little vehicular traffic, setts being laid next rails." Well, that was a very common practice on country roads, and is still, and I do not know how you can get over it, because no one would propose to pave the whole width of a suburban road. The objection to the macadam, of course, is that loose stones, grit and mud get into the rail grooves and have to be cleaned out. The effect of "guttering" or "rutting" in the adjoining pavement is a trouble we all have. I do not agree with the suggestion to use chilled iron chequer blocks as a preventive of rutting. Where you mix up the materials it tends to make the road very unpleasant to travel over.

Mr. A. H. Campbell: Coming from the thick of tramway construction at the present time the paper appeals to me particularly. Undoubtedly it is a perfect wealth of information to us on all matters of tramway construction. Mr. Smith

has given without stint from the fulness of his knowledge and has withheld nothing, and certainly the paper is one that deserves our very best thanks. With regard to the question of paving which has been touched upon, Mr. Smith mentions tar macadam. Possibly as the Members of the Association know, I have had some experience of tar macadam, and in bringing that material before the Association I may have induced some of the Members to adopt it. But I reccommended the use of tar macadam for ordinary road construction; my experience of it as applied to tramway tracks is that it is an absolute failure. What applies to an ordinary road does not apply to a tramway track where the traffic gets concentrated, and converges along the track. We have had experience of its failure, and also of its success at East Ham, but it is only a success where we have laid down the improved tar and asphaltic macadam as prepared by Hobman and Co. On the ordinary tar macadam, made up of 1½-inch to 2 inches of granite mixed with tar, we pour a covering of Trinidad asphalt as a flux. We have tried that under all conditions of weather, wet and dry, hot and cold, and it is wearing well and giving us no disappointment. Anything which can contribute to the economy of tramway construction will lead to the extended use of tramways, especially in suburban and inter-urban districts, and it may be found that the modified composition of tar macadam which I have described, will satisfactorily fill a want on such roads. We have also laid sanitary tile blocks, which come midway in cost between tar macadam and ordinary granite setts, and our experience of this paving is very satisfactory. The clear ring of the horses' hoofs upon it is satisfactory evidence of its durability. We have not all of us the privilege of living in Leicester, and granite is consequently very expensive. We cannot get it down in East Ham for less than 18s. a yard, and the noise is also objectionable. We have laid 1000 lineal yards of the track in Jarrah wood, of which we have had to take up 60 yards owing to expansion. I hope that there may be some practical result from this paper, with respect to the standardising of rails for tramways. I agree with Mr. Smith that the adoption of a standard rail would economise the cost of tramway construction, and I would like to support the suggestion that this Association be represented before the Standards Committee.

Mr. S. S. PLATT: I think a word or two more ought to be

said in the way of thanks to Mr. Smith for this admirable paper. There is no doubt it is one of the most complete contributions on the subject which has yet appeared, and some of us would have been very much obliged if we could have had this information in our hands some months or years earlier. Mr. Smith has epitomised in a most able manner the best tramway practice in this country. There is much in this paper that is deserving of careful consideration. With regard to the length of rails, I am at present using 60-foot rails, but I am of opinion 45-foot rails are sufficiently long, as the 60-foot lengths are unwieldy to handle and involve a considerable amount of trouble. I notice that Mr. Howard Smith has referred to the absence of fishplates on the tramway system at Blackpool. I do not know whether that has had anything to do with the trouble they have recently met with there as to variation of gauge. Certainly I should hesitate to dispense with fishplates. The matter of points and crossings is more important than many people think. With regard to passing places, I do not see any reference to interlacing and double track for a better electrical return. Personally I do not like interlacing. When I saw the interlacing arrangement at Blackburn I did not like it, and a few days afterwards the drivers of two cars tried to pass in opposite directions on the interlacing track and a serious collision occurred. In regard to paving, I was very pleased to hear Mr. Collins' remark about the use of "basalt lava" at Norwich. I am putting down a trial length of this material in front of a place of worship in my district instead of wood. If the district is pretty extensive and you have patches of wood paving here and there in front of places of worship, it is not conducive to the temper of the Municipal Engineer's subordinates to have to send out to sand these isolated patches in frosty weather. The experience of some tramway managers is chilled iron wheels have not anything like the life expected of them, and that they contribute a very great deal to the damage of the track. They are supposed to run 30,000 miles, but I have heard that many have worn out that have not run 10,000 miles, and that steel-tyred wheels are considered preferable. I cordially support the vote of thanks to the Author for his admirable paper.

Mr. W. N. Blair: While I cordially agree with all who have spoken as to the value of the paper, there are one or two

points in it upon which we are entitled to differ from Mr. Smith. In referring to guttering and rutting, Mr. Smith suggests the use of chilled iron chequer blocks as a preventive. I agree with Mr. Yabbicom in condemning the use of chilled iron blocks. They are a source of great annoyance to anyone living in the neighbourhood. They wear at a less rapid rate than wood or granite and they cause a continuous rattle, so much so that the Highways Committee in my district called upon the Tramway Company to remove all these chilled blocks. One other suggestion is the use of narrow steel strips. Much against my will, but in obedience to directions, I put down steel strips on to each course of a length of wood-paving of the tramways, as it was suggested that they would add to the durability of the wood, would prevent the forming of ruts against the rails, and would be practically everlasting. They were not. In a very few weeks they jumped loose, and in two months had to be taken out. Those are points which I speak on from experience, as a warning to anyone against adopting them on a large scale. Mr. Smith condemns practically wholesale all whinstones and basalt granites. Of course we know some whinstones are very slippery, but we know that others are non-slippery. We talk of Leicestershire granites, but Leicestershire granites vary as much from each other as chalk from cheese, and you may get a non-slippery as well as a slippery granite. Whinstone I admit is generally a slippery stone, but I know a whinstone which comes from Barrasford, Northumberland, which is absolutely non-slippery: though it is not so durable as Penmaenmawr stone. Mr. Smith recommends that where the paved margins adjoin macadam it is best to lay the setts with a straight edge instead of a serrated edge or toothing next to the macadam. If you pave with a straight edge you will get a ridge, formed by wear of the macadam, of an inch or an inch and a half, which will be quite sufficient to cause a wheel to skid against the ridge. It is true you cannot roll the macadam into the toothing, but you can roll to the outer edge, and it is quite as effective as if you were rolling it to a straight edge. The toothing enables the wheels to pass much more easily from one material to the other than if you have got a straight joint.

Mr. F. Spencer Yates: I think this is one of the most comprehensive papers which has ever been put before the

Association. It contains a mass of detailed information which we cannot possibly discuss in the time at our disposal. I was pleased to hear Mr. Collins ask for further information with respect to joints, because the joint is one of the most important factors in connection with tramway construction. The question of the life of the track is now of much greater moment than it was in the days of horse traction. Fishplate joints have one great recommendation, they can be fixed without the rail being lifted after the cement foundation has been laid. With respect to the anchor joint, I should like to ask Mr. Smith whether he has found by experience an absolutely safe and sound foundation of concrete under the joint can be got so as to prevent it giving afterwards. One of the great features with respect to joints is they suffer more from vibration than anything else. Another point is to prevent percolation of water in the joint. One way to prevent that is to lay the joint as close as possible. With reference to the length of the rail, I do not think there is any great difference in handling between a 60-foot and a 45-foot rail, and the use of the longer rail reduces the number of joints. The chief difficulty, if a foreign-made rail is being used, is that of shipment. Long rails can be obtained easily in this country, but if a foreign-made rail is used there is difficulty in getting ships that will carry them in large quantities, and in consequence of this there may be delay in delivery. Another point I wish to mention is with respect to the width of the groove. Mr. Smith favours a 1⅛-inch groove. Personally I think that should be an absolute maximum, because other traffic has to be considered on the roads besides electric trams; also with a wide groove, unless the wheels of the car have a wide flange, there is more side play and therefore more swing on the car.

Mr. H. G. Whyatt: I desire to support the vote of thanks to Mr. W. Howard-Smith for his excellent paper; I would also add my support to the request that many of the diagrams shown upon the wall should be appended to the paper when it appears in the Annual Proceedings. With regard to the laying of concrete as mentioned, I think the second method is preferable, but with this alteration, namely, that the concrete bolsters should be made of a substantial size and fixed at once permanently at 9-feet or 10-feet intervals, and not temporarily: after these are carefully fixed to the exact level, the rails are laid in position, and the main concrete is packed in between

them. I also agree with the remark as to laying the 18-inch margin with a straight edge, but for another reason than the one given by Mr. Howard-Smith. In Grimsby the tramways are leased to a company, and it is occasionally alleged by the company that, in rolling the macadam on the sides of the roads, the 18-inch margin is displaced by the roller. If the margin were laid with a serrated edge, as suggested by a previous speaker, this trouble would be accentuated, and legal difficulties might arise. I venture to suggest that it would be more in accord with experience to say that the insertion of narrow steel strips has proved " equally objectionable and inefficient."

The PRESIDENT: I will express on your behalf our very great appreciation of the time and ability Mr. Smith has devoted to this very interesting question. I much regret the imperative necessity of curtailing the discussion. I am sure you will forgive me for this, and join with me in expressing our appreciation of the very great care Mr. Smith has given to the preparation of this most valuable paper.

The vote of thanks was unanimously passed.

Mr. HOWARD-SMITH, in replying, said: I am exceedingly flattered by the reception given to this paper. It has amply repaid me for the time devoted to its preparation, and I shall be pleased to prepare some of the drawings exhibited in a form which will enable them to be reproduced in the Transactions of the Association.

Mr. Yabbicom inquired whether I had had experience of rail guards on curves being raised to a height of from 1 inch to $1\frac{1}{8}$ inch above the rail tread. I cannot say that I have ever known or before heard of such a case; the height mentioned seems to me quite abnormal, and could only be requisite under very exceptional conditions; if in a public highway, such a state of circumstances would undoubtedly form a serious danger, especially to bicycles and light vehicles.

Mr. Collins and Mr. Yates have referred to the great interest to be attached to the question of the stability of the rail joints, and with this view I quite concur. It is indeed one of paramount importance, and should therefore receive every attention. The subject would be well worthy of several hours' discussion amongst us. As Mr. Yates has said, the rail joint is one of the most material factors in the construction, running and maintenance of electric tramways, the whole life of the track

being practically dependent upon that of the rail joint; and it is the height of unwisdom to use anything else but a thoroughly effective joint, which will repay many times over the small extra cost involved. I have made reference to and shown drawings of almost all forms of rail joints at present in use; and with regard to the anchor joint plates, I can only say that after an experience of their use in a large number of tramways they are found to make a thoroughly trustworthy joint, keeping the rails in perfect alignment and obviating any necessity for packing. The principle of this joint is to practically form a continuous rail with the joint at least as strong as the remaining part, and by the anchor plate being firmly embedded in the concrete all movement, lateral or vertical, is prevented.

With reference to the difficulty of providing a tramway paving which shall give a safe foothold for horses, I have had some experience of the basalt lava stone setts to which Mr. Collins has made allusion, and have seen them laid on gradients as steep as 1 in 13, the surveyor stating that they had proved non-slippery and were giving every satisfaction.

As to whether or not wood paving can be safely laid on gradients steeper than 1 in 18, while, as Mr. Yabbicom says, this may be done on an ordinary roadway, the legal responsibility attaching to horses slipping on a tramway track, makes the use of wood undesirable on steep gradients, particularly as Mr. Platt points out, it will require to be sanded, and seeing the objection there is to grit getting into the rail grooves.

The point I wished to emphasise with reference to the use of macadam for paving tramway tracks, was that care should be taken not to make the camber too great as there was a possibility of the car fender striking loose stones and ploughing up the surface, as has happened in more than one instance.

I am in accord with Mr. Blair's objection to the use of chilled iron blocks; for, as I have pointed out, they are both noisy and costly, and I am not very partial to steel strips, but regard their use as a choice of evils.

Upon the relative merits of chilled iron or steel-tyred wheels, my experience leads me to confirm Mr. Platt's views. There is no doubt that the great hardness of chilled iron tyres is detrimental to the life of the rails, points and crossings, and the wheel flanges are so brittle that they are subject to be broken

off by coming in contact with stones or pieces of metal that find their way into the rail grooves.

As to the best length of rails, after carefully weighing all the bearings of the question, I favour 45 feet. I have used considerable quantities of 60 feet, but am now convinced that, for making the best work, as well as for eventual economy, the shorter length is to be preferred.

I am pleased that you have received with such unanimous approval the suggestion that this Association should be represented before the Standards Committee, as the question of standardising rail sections and other tramway materials is undoubtedly one of real importance.

METHODS OF SAFETY FOR THE OVERHEAD ELECTRIC TROLLEY SYSTEM.

BY EDWARD MANVILLE.

THE rapid growth in this country of late years of tramway systems operated electrically on the overhead trolley system has drawn public attention to its merits and disadvantages; and the Corporation of Leicester having recently determined to install this system for the Leicester tramways, makes this occasion a peculiarly appropriate one for the consideration of such a subject by the Association.

The limits of this paper will not permit of a consideration of the whole of this somewhat extensive subject, and the Author therefore proposes to confine himself to the methods which may be adopted for ensuring safety to the public when using the tramways or the streets in which they are laid.

For the convenient consideration of this paper it is divided into two parts:—

1. Precautions to be taken to ensure solid construction.
2. Methods of ensuring safety should a breakdown occur.

PRECAUTIONS TO BE TAKEN TO ENSURE SOLID CONSTRUCTION.

Obviously it is most important that the overhead trolley system, when installed, should be of such solid construction and excellence of design that with a comparatively limited amount of inspection there shall be the smallest possible liability to breakage of the "live" conductors, or of parts carrying these, and to entanglement of the trolley wheel with the "live" conductor, the guard wires and their fittings.

In the first installations made on this system abroad both the trolley wire and the fittings supporting it were very light,

and liable to fracture when subjected to comparatively small extra strains.

It was originally the custom to use 1/0 B. & S. trolley wire of hard copper or phosphor bronze, having usually a tensile strength of about 24 tons per square inch section; consequently a trolley wire of the size mentioned would part when subjected to a strain of 4560 lbs.

The numerous accidents occurring from the use of so small a wire, and the fittings proportionate to its size, gradually caused the introduction of larger sizes of trolley wire, 1/0 wire being replaced by 2/0, having a breaking strain of about 5230 lbs., and this size being itself superseded in the most modern installations by 3/0 wire, having a breaking strength of 6580 lbs.

As the wire used was increased in section, so the fittings supporting it were increased in size and strength, until the 3/0 wire, as installed to-day, has become an exceedingly strong and substantial structure.

No doubt the length of time that has elapsed in the adoption of the heavier wires, having regard to the accidents that undoubtedly occurred with the lighter ones, has been due to the fact that, especially in this country, it was believed the heavier wires and fittings would be more perceptible to the eye than those of lighter character; but the actual installations of those that exist show conclusively that, at the height above the road level which they occupy, small differences in size are quite imperceptible, and certainly do not, so far as that reason is concerned, warrant the sacrifice of anything in the shape of the extra safety secured.

The provision of the heavier trolley wire does not necessarily mean a perceptible increase in the cost of the tramway system, since the extra copper thus put into the trolley wire effects a material saving in the cost of the insulated distributing wires laid underground.

On the table are samples of the earlier type of fittings with single 0 trolley wire, as originally used, and a sample of 3/0 trolley wire with one of the most modern type of fittings used for supporting it.

In addition to making the trolley wire and the fittings directly supporting it of ample strength, it is of course equally necessary that the further fittings required to attach these to

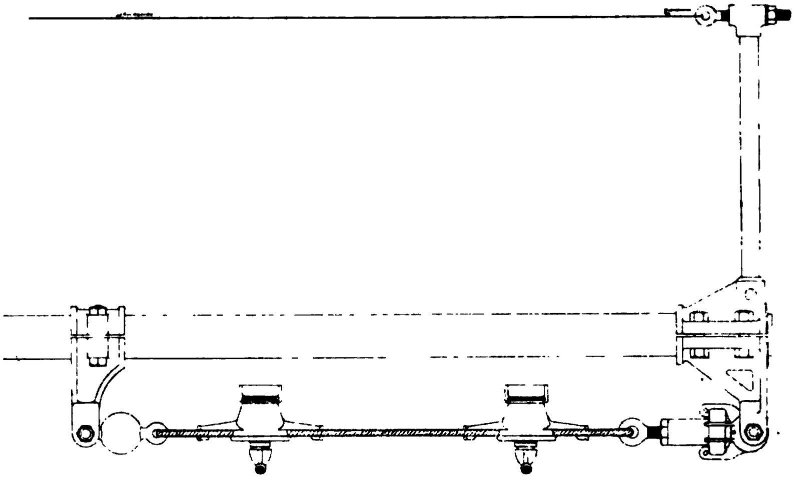


Fig. 1

Guard Wire Support on Straight Lines.

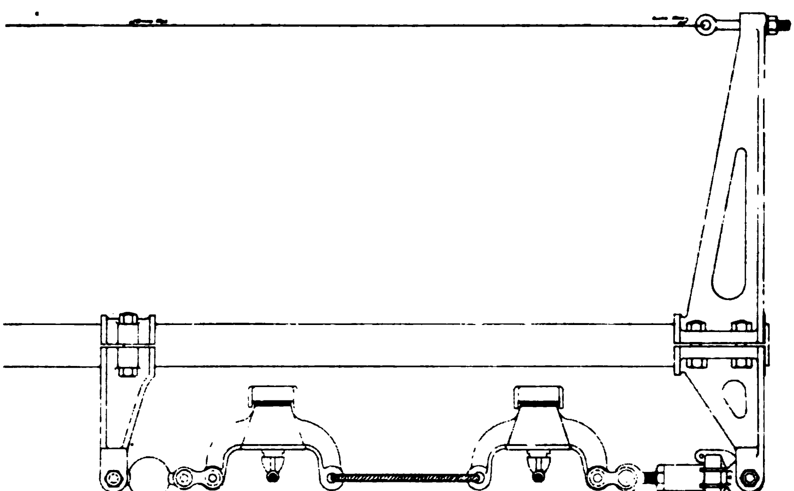


Fig. 2

Guard Wire Support on Curves.

POST OFFICE ARRANGEMENT OF GUARD WIRES

Fig 3

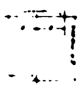
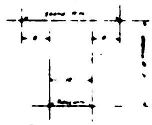
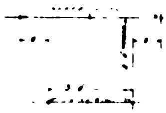


Fig 4



2 Trolley Wires up to 18" apart

Fig 5



2 Trolley Wires up to 2' 6" apart

Fig 6

2 Trolley Wires over 2' 6" apart

Fig 11.

TROLLEY STANDARD.

— Guard Hooks & Guard Wires —

Fig 7

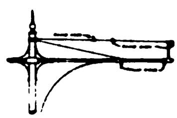


Fig 8

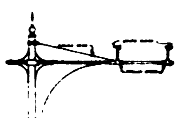


Fig 9

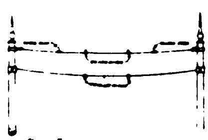
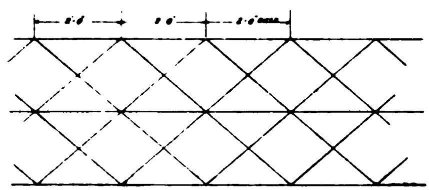


Fig 10

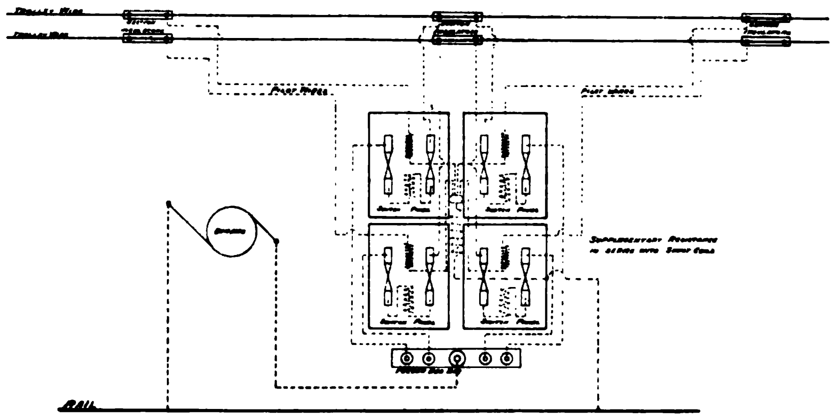
—Method of Cross Lacing—

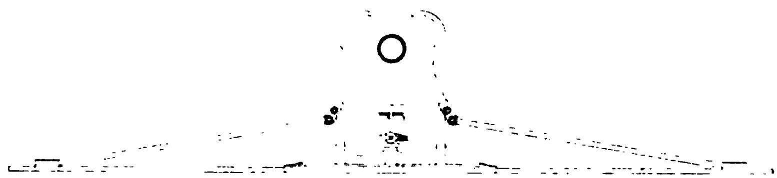


— Quin's Safety Device —

Diagram of Connections

Fig. 13.





Trolley Wire Earthing Device
with Special Ear
Fig 14

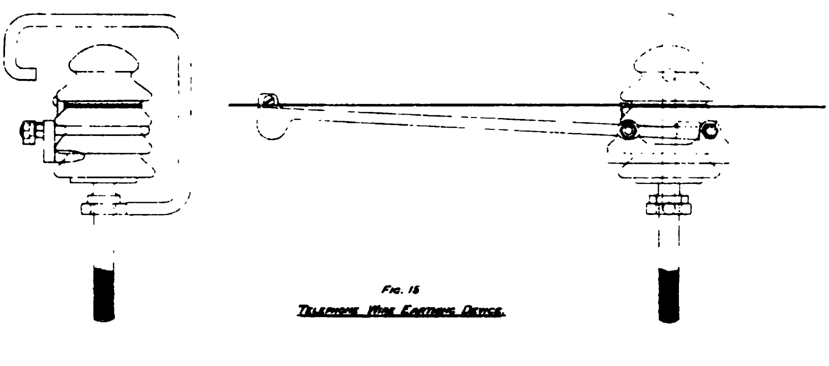


Fig. 15
Telephone Wire Earthing Device.

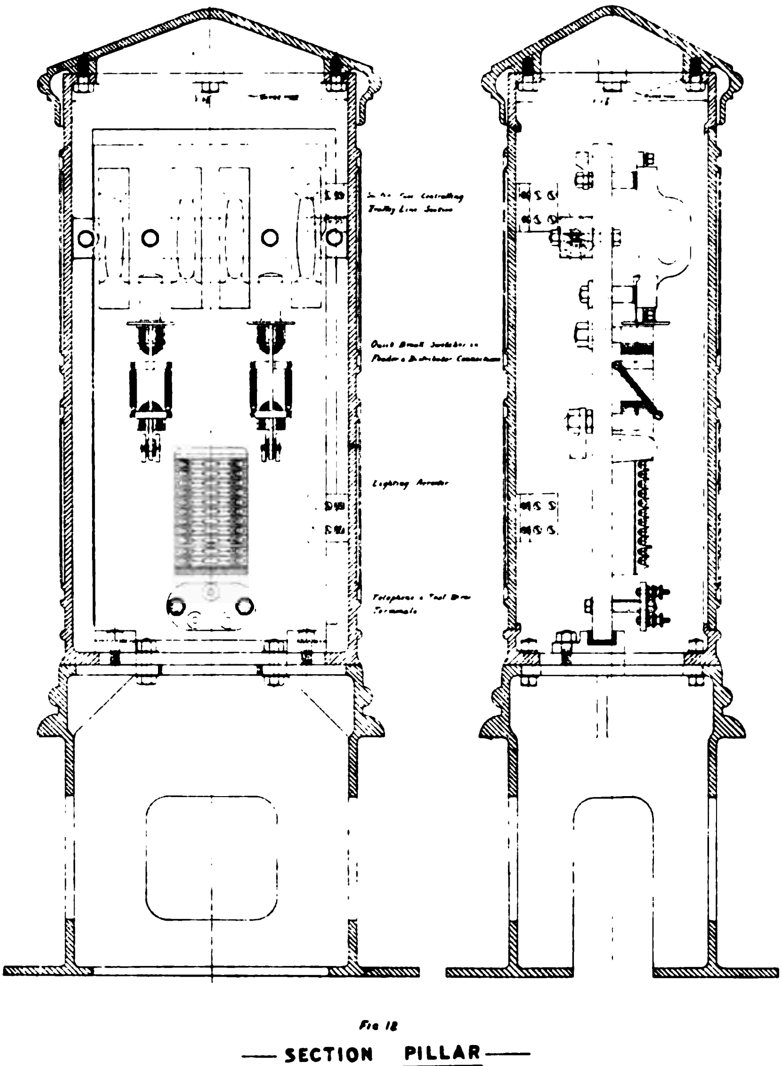


Fig 12

—— SECTION PILLAR ——

the bracket-arms or the cross suspension wires—if used—should be of equally substantial design, and the brackets themselves should be proportioned to have an ample margin of strength to withstand strains that may be thrown upon them through the trolley wire.

In the gradual growth from the 1/0 to the 3/0 construction there has been a tendency, whilst adapting the heavier trolley wire and fittings, to consider that the minor details used in the lighter construction were sufficiently strong for the heavier construction. For instance, $\frac{5}{8}$-inch bolts, which were universally used for the light insulating ears, are quite unsuitable for the heavier ears, and it is to be particularly noted that for this purpose no bolts less than $\frac{3}{4}$-inch in diameter, and of mild steel, should be used.

In the same way the fittings on the steel street-standards themselves, where used for the attachment of cross suspension wires, or for the securing of the bracket-arms to the poles, should be made of no less reliable material than malleable iron castings; although one sees in a good many instances cast-iron fittings of this description used for the purpose, as formerly.

To ensure effective insulation of the trolley wire, the insulation should be double throughout. In the case of cross suspensions, the insulated bolt carrying the ear to which the trolley wire is attached, is the first insulation; the second insulation forming a portion of the straining apparatus used to take up the sag from the cross span. In the case of bracket-arm suspension, the first insulation as before, should be the insulated bolt supporting the ear, and the second a layer of insulating material between the clamp to which the hanger is attached and the bracket-arm itself; but where flexible suspension is used in connection with a bracket-arm in place of the rigid suspension, the same arrangement of double insulation should be used, as in the case of the span wire construction.

Next only in importance to the strength of construction of the trolley wire arrangements are the methods which should be adopted to ensure as far as possible the absence of contacts between falling telephone or telegraph wires and the trolley wire.

This is usually effected by placing guard wires parallel to and above the trolley wire, so arranged that there may be but little chance of falling telephone or telegraph wires evading

the guard wires, and thus coming into contact with the trolley wire.

The guard wire should be proportionately quite as substantially supported as the trolley wire, and should be of such section that the accidental contact of a falling wire simultaneously with the guard wire and the trolley wire will ensure the operation of the circuit-breakers and other safety devices used, so that the current may be instantly cut off on that section of the trolley wire on which the accident occurs.

The guard wires should be of galvanised stranded steel, of not less than $\frac{3}{8}$-inch in diameter, and supported in a thoroughly substantial manner. Fig. 1 shows the most approved form of flexible bracket arm suspension now being installed on the straight lines; and Fig. 2 modifications of the same form of suspension when used on curves. In both cases the supports for the guard wires are also shown.

In the latter case, i.e. the method of construction for curve work, it will be noted that the fittings are very much strengthened as compared with those used on straight lines, which used not to be the case in earlier installations.

Samples of both types of suspensions are shown, and likewise samples of the better forms of fittings for use in connection with the guard wire.

Arrangement of Guard Wire.

To ensure the better protection of overhead telegraph and telephone wires from contact with the trolley wire, great consideration has been given to the best methods of arrangement of the guard wires in reference to their position to the trolley wire, and the latest Regulations issued by the Post Office authorities in this respect, probably represent the best arrangements.

(*a*) *Telegraph or telephone wires crossing above trolley wires.*

1. When there is only a single trolley wire or two trolley wires not more than 12 inches apart, two guard wires should be erected, as shown in Figs. 3 and 4.

2. When trolley wires are more than 12 inches apart, and do not exceed 3 feet, the guard wires should be increased to three in number, as shown in Fig. 5.

3. When the distance separating the trolley wire exceeds 3 feet, each wire should be separately guarded, as shown in Fig. 6.

(*b*) *Telegraph or telephone wires parallel to trolley wires.*

In all cases in which telegraph or telephone wires and trolley wires are parallel, and within 30 feet of one another, suitable hooks should be fixed on the arm, stay, or on the span wire to support the guard wires which should be erected on similar lines to the above. This is shown in Figs. 7, 8 and 9.

These last arrangements of course refer only to a case where the telegraph or telephone wires are at a higher elevation than the trolley wires, so that broken wire may be blown transversely across a trolley wire. Where, however, the telegraph or telephone wires are at or about the same height as the trolley wire, when there would be no possibility of this happening, the guard wires need not be provided.

(*c*) Where the telegraph or telephone wires are so close to the trolley wires as to render the foregoing protection insufficient, the guard wires should be cross-laced as shown in Fig. 10. This cross-lacing forms a hammock netting, on to which the broken telegraph or telephone wire would fall, and is a very effective protection.

The same arrangement can be used with great advantage where a number of telegraph or telephone wires are crossing the trolley wires, and not running parallel to them, in which case the "hammock" can be suspended under the telegraph or telephone wires from pole to pole at the point where they cross the trolley wires. In such cases, however, it is probably better to arrange with the Post Office authorities or the Telephone Company that the mass of wires shall be dispensed with, and an insulated cable containing all the conductors be substituted therefor—a matter not of very considerable expense, seeing that only one span of the telegraph or telephone system is involved in such an arrangement.

With the above arrangements effectively carried out, it is not very probable that a falling wire will come in contact with the "live" trolley wire, and it is highly improbable, should it

do so, that it will fail to make contact with one or other of the guard wires. At the same time that this happens the falling wire would either be fused off at once, or failing this, would operate one or other of the safety devices referred to hereafter.

To ensure the operation of the safety devices by the short-circuiting of the trolley wire on the guard wire, it is essential that the guard wire should be in thoroughly good electrical connection with the track, and this should be effected by the direct connection of the base of the steel street standard to the nearest rail in at least one and preferably two cases in each detached length of guard wire.

It is somewhat curious to note in this connection that in the older installations it was considered desirable to insulate the guard wires, in place of effectively earthing, as is now the recognised and only safe practice.

Rolling Stock.

Danger may arise in two respects from the rolling stock:—

1. Entanglement of the trolley arm with the overhead construction.

2. Shocks to passengers.

The entanglement of the trolley arm with the overhead construction in older installations was a constant source of accident. This has been to a very large extent overcome by the proper guarding of the trolley wheel, so that in the event of this leaving the trolley wire and coming in contact with the cross-suspensions, bracket arms or other fittings, it can hardly become entangled with any of these; and this is further helped by the trolley arm being so arranged as not to rise further than a pre-determined limit when off the trolley wire.

Perhaps there is more liability to accident and more difficulty in guarding against it in connection with the trolley arm than with any other portion of the system; and although the substantial construction of the overhead system as previously described will almost certainly prevent any disturbance to this should the trolley wheel become entangled, it is in that case difficult to prevent the trolley head being itself pulled off the trolley arm. For this reason the trolley arm should be long

enough to carry the head free of the car, so that, should it be dropped, it will fall clear of the passengers.

Electric shocks to passengers carried on the cars are very rare, and should not occur at all if the precaution is taken of thoroughly "earthing" all metallic parts of the car, including the trolley standard itself.

The springs used to give the trolley arm the requisite upward pressure against the trolley wire, if arranged externally, might also be a source of annoyance to passengers, and these springs should therefore be arranged within the trolley standard. This has been done very effectively lately in connection with a tramway with which the author is concerned, and will no doubt in the future be a standard arrangement.

Fig. 11 shows a complete drawing of a trolley standard, and there is on the table a sample of a patent form of swivelling shielded trolley head which has been found very effective in practice.

Methods of Ensuring Safety should a Breakdown Occur.

If, notwithstanding the substantial construction advocated, a trolley wire should break, or if telegraph or telephone wires should come in contact with the "live" trolley wire, it is essential that means should be provided for immediately rendering that particular section of the trolley wire inoperative by automatically disconnecting it from the generator.

In the earlier installations, and even to a certain extent to-day (abroad) the trolley wires and feeders were so interconnected and unguarded that an accident to one part of the system either produced serious results or involved the shutting down of a large part of the system on account of one local fault.

To guard against this and to enable suitable safety devices to be effectively operated, the trolley wire should be divided into sections, not exceeding half a mile in length, and as few of these sections as possible fed through any single feeder proceeding direct from the source of supply.

In between the adjoining sections of the trolley wire properly designed section pillars should be connected enabling any section of the up and down trolley wire to be disconnected from the circuit whilst continuing the supply to the remainder.

The section pillar should be arranged so that the discontinuance of the supply of current to the particular section of trolley wire may be brought about either by the melting of fusible connections, the operation of hand or automatic switches, or a combination of these.

The ends of the feeders supplying the fewest possible number of these sections should be suitably protected in the generating station by an automatic switch, arranged to open the circuit when a moderately larger quantity of current than the normal passes through its windings. Then, should a telegraph or telephone wire fall across the guard wire, and, at the same time by accident, come into contact with the "live" trolley wire, a sufficiently large flow of current will take place through the short-circuit thus produced to either melt the fuse or operate the automatic switch in the section box, in which case that particular section of the trolley wire only will be automatically put out of action, or, failing the effective action of the fusible cut-out or automatic switch in the section-pillar, the circuit breaker at the end of the feeder in the generating station will open, stopping the supply of current in that case to the section of trolley wire on which the accident has occurred, and also the other sections of trolley wire fed by the same feeder.

It will be obvious that in carrying out such an arrangement the sections of trolley wire fed from one feeder must not be inter-connected with the sections fed from the other feeders, but the section boxes themselves should be provided with switches which will enable the gaps to be bridged over between adjoining trolley wire sections, fed off separate feeders, when a faulty section has had to be cut out.

Fig. 12 shows the general arrangement of a section pillar now in almost universal use on tramways in this country, varying only in the details of arrangement. In the figure in question fusible cut-outs are used for connecting up the various trolley wire sections to the distributor, and switches are provided for connecting up the distributor and the feeder. The fusible cut-outs are arranged to be used as switches when it is required to temporarily disconnect any trolley wire, and the switches are available for disconnecting the distributor or feeder for testing or other purposes.

The feeder pillar also contains the terminals for the recep-

tion of the ends of telephone cables—the instruments themselves being carried on the cars—and terminals for the ends of the Board of Trade test wires; and in the case of any special safety device being used, such as the "Quin" automatic switch, described later on, the section pillar should also be arranged to contain any such fitting. [A sample of complete branchway switchboard for use in section pillar is exhibited on the table.]

The above arrangement may be described as the more usual arrangement adopted up to date, and whilst, if properly proportioned, it would be effective for the cutting out of trolley wire sections when telegraph or telephone wires have come in contact with them, it is not generally applicable to accidents which might occur from the breakage of a trolley wire, the ends of which would hang down to the roadway, and which, unless the ends came into actual contact with the rails, might not convey sufficient current to open the circuit bearers or melt the fuses, and therefore might remain "alive," to the danger of any animal or person coming in contact with them.

To meet this exigency several devices have lately been designed to ensure the circuit being opened as surely when a trolley wire is broken as when it is short-circuited to the guard wires through a fallen telegraph wire. These devices may be divided into two classes:—

1. Automatic switches requiring a pilot wire for each section of trolley wire, carried the whole length of the half-mile section.

2. Mechanical devices brought into action by the severance of the trolley wire.

The best-known example of the first of the above-mentioned types, namely, automatic switches requiring a pilot wire, is that designed by Mr. Quin, of Blackpool, and in use upon the electric tramway system there.

This device involves the trolley wire being divided up into sections, which are not, as is otherwise usual, inter-connected with the adjacent ones.

Each of these automatic switches has a main solenoid coil in series with it, and is so arranged that, should the current passing through this coil exceed the predetermined amount for which it is adjusted, a plunger within the solenoid is drawn up against two catches and releases the switch, so that in case of

short-circuiting or excessive current the line is automatically cut out. At the back of this switch there is a shunt solenoid coil which is in series with the pilot wire, which may be run either overhead on insulators or as an insulated conductor underground at the end of the trolley wire section the switch is intended to control, and is there connected to the trolley wire.

So long as the pressure between the trolley wire and the rails remains at about 500 volts this shunt coil holds up the plunger within it, but if the line were to break and the pressure thereby be cut off from the pilot wire and, therefore, from the shunt coil, the plunger would be released, falling on to two catches and operating the switch, thus automatically cutting off this section of the trolley wire.

In this way this particular switch takes both the place of the fusible cut-out previously referred to and, in addition, ensures the current being cut off from the trolley wire should the wire be broken.

It has, however, one disadvantage, and that is, that no current can be put on to any of the sections of the trolley wire until the switch has been set by hand once the pressure has been taken off the line, so that after shutting down at night it is necessary for an official, on the first car proceeding out in the morning, to stop at each section pillar and set the switch for the succeeding section before the car can proceed over it; whilst, should there be an accidental short-circuit during the hours of operation of the tramway which might for a moment cut off the current entirely from the power house, it would again be necessary for all the switches to be reset by hand as the cars proceeded.

A diagram of the connections of the Quin switch is shown in Fig. 13, and a sample of the switch is exhibited.

The second type, that is, mechanical devices for cutting off the current and coming into operation by the severance of the trolley wire, depend for their action on the short-circuiting of the trolley wire to the rails, thus either melting the fusible cut-outs or opening the circuit breakers as previously described, in the case of any ordinary excess of current taking place.

So far as the Author is aware the only devices of this description that have yet been put into operation are those designed by Messrs. Blackwell and Co.

In each form of this apparatus the necessary short-circuit is produced by a short lever being pulled over either against the bracket arm, when either the rigid or flexible suspension type of bracket construction is used, or against a loop hanging from a special earthing wire carried over the trolley wire when the cross suspension method of construction is in use.

Fig. 14 shows one form of this device as adapted to the flexible suspension bracket arm construction. From this figure it will be seen that the lever remains in a vertical position so long as there is no pull on the short stay wire connecting the short end of the lever with the trolley wire. Should the trolley wire break at any point along the span, a considerable pull is exerted on the short end of the lever which brings the longer end immediately into contact with the bracket arm, exerting considerable pressure between these two points, and ensuring a good contact to earth with a consequent short-circuit and sufficient flow of current to melt either the fuses in the section box or open the circuit breaker in the power house. The extreme simplicity of this device has much to recommend it.

The same device might be conveniently used for safeguarding telegraph or telephone wires where they cross the trolley wire, and where they are not in sufficient numbers to make it worth while substituting an insulated cable, as recommended in an earlier part of this paper.

Fig. 15 shows the modification of this device under such circumstances.

The telephone pole, at points where the wires cross the trolley wire, must be permanently connected to the rail. The lever shown in the figure is fixed to each insulator by means of a clamp, and the weighted end is attached to the telephone wire. The stirrup shown is connected either through the pole to the rail, or, should the pole be a wooden one, through a special wire attached to each stirrup and connected to the rail. Should the telegraph or telephone wire break, the weighted end of the lever drops, and brings the other end into contact with the stirrup, thus earthing the broken wire.

If the broken wire has come into contact with the trolley wire, sufficient current will flow through the trolley wire to the telephone wire to either melt the fuses in the section box, or open the circuit breaker in the power house, or, alternatively, to fuse off the telephone wire itself. In this case the weight of

the breaking telegraph or telephone wire would assist the movement of the weighted end of the lever.

The author trusts that this description of means for rendering the overhead trolley system safe has not taken up too much of the time of the Association, and his excuse must be that the increasing number of installations of this system in the country is such as to demand the careful consideration of all concerned in eliminating as far as possible the chances of accident.

DISCUSSION.

Mr. J. LEMON: I have very much pleasure in moving a vote of thanks to Mr. Manville for his kindness in attending this meeting and giving us so valuable a paper on the overhead system of electric traction. I have met Mr. Manville before to-day, as his firm are engineers to the electrical tramways and works at Southampton. I can say that the works carried out from the designs of the firm have been a brilliant success, and if they are as well done in Leicester as in my borough, Leicester will have no reason to regret appointing Mr. Manville as their engineer. Of course engineers have to decide some time or other which is the better of the two modes of electric traction, the overhead or the underground. I presume we must all have come to the conclusion before now that there are advantages and disadvantages in both systems, and it is a question which system has the fewest disadvantages. After giving the two systems a good deal of consideration in Southampton—and I was chairman of the Works Committee at the time—we came to the decision that the overhead system was the best to adopt. There are dangers, and will be dangers in all systems of this kind. There are dangers in every form of mechanism you can have; but such advances have been made by electrical science that those dangers are reduced to a minimum. It must not be forgotten, if you introduce the underground system you may have a good deal of trouble with gas and water mains. I know that in London some of the gas and water companies have asked Parliament to assist them from any dangers likely to occur from underground currents, but Parliament, I think very properly, has refused to do so. With reference to the danger from telephone wires falling across the

overhead wires, we have got over that in Southampton by refusing to allow the telephone companies to put wires overhead. I cannot see what business a telephone company has to go to the top of a man's house and put up a station, sometimes with a man's consent and sometimes without. One of the objections raised to the overhead system is its unsightly appearance. Well, I have visited several towns where the overhead system is in vogue, notably Hamburg, and I came to the conclusion, after being there 48 hours, that I had forgotten the overhead wires altogether. I have not heard a single person who has become accustomed to it raise an objection to the unsightliness of the overhead system. There are certain advantages about it. If you have a breakdown it is visible, but if you have a breakdown underground it is not so easy to find. Sometimes we have a breakdown of the electric cable supplying light to the houses, and it takes time to locate the breakdown. That is not so with the overhead system. It may appear a little unsightly when first installed, but when the public have become accustomed to it they will become convinced that it is the better system of the two and far the more economical. If you will go into the question of cost, you will come to the conclusion that if you have to put down an underground system as in London you will not put down a system at all. I propose a hearty vote of thanks to Mr. Manville for his able paper on the overhead trolley system of electric traction.

Mr. J. LOBLEY: I have much pleasure in seconding the vote of thanks to Mr. Manville for his paper. It is rather amusing to find how unanimously everybody is now in favour of the overhead system. I remember I was in a very considerable minority nine years ago, when I said very much the same as Mr. Lemon has said to-day. I had not been in Boston (U.S.A.) two days before I had become used to the overhead trolley system there. From that time I have never seen any reason to change my opinion. Last week there were some illustrations in the 'Engineer' of the tramcars now in use in Paris. When in Paris last September, I was very much struck by the hideous monstrosities of cars running on the compressed air system. The engines are like the old North Staffordshire steam cars, and they are followed by two or three trailers. There is no comparison between that system and the overhead

trolley system, which is far superior in speed, accommodation and appearance, even including the overhead wires. We have every reason to thank Mr. Manville for his paper, which has come at a very opportune moment. We are always being told of the dangers of the overhead system since the Liverpool accidents. I do not think those accidents would have occurred if they had used guard wires instead of wooden strips in Liverpool.

Mr. J. Gammage: We have for some time had the overhead electric trolley system in Dudley. When the system was first proposed the general public were up in arms against it, but since the tramways have been constructed and in working order we have not had a single accident from the trolley wire, and the public are quite satisfied. In fact, as regards the unsightliness, it is as other speakers have said, you forget about the overhead wires when you are walking about the streets; you do not notice them. There is one advantage in having the overhead system which my Corporation took advantage of, by the arrangement that they should use the poles for street lighting purposes by electric arc and incandescent lamps. We have used the poles in this way, and, instead of disfiguring the streets, the poles have become ornamental. There are also less pillars in our streets than gas lamp pillars.

Mr. T. H. Yabbicom: I would like to ask Mr. Manville if he considers there is greater safety—or perhaps I might say less danger—in supporting a trolley wire from a bracket than from a span wire? With reference to the relative merits of the span wire and bracket system, the span wire does give an engineer a better opportunity of fixing his points. I am rather in favour of the bracket from the point of view of appearance, but from the point of safety I should like to ask Mr. Manville which he considers the best, and whether these appliances as described are applicable to span wires.

The President: I have very great pleasure in putting a vote of thanks to Mr. Manville. I can only say on behalf of the Chairman and Vice-Chairman of the Tramway Committee who have given immense interest and study to this question, that we are very grateful to Mr. Manville for coming down here to-day, and we consider ourselves very fortunate in having secured the services of Mr. Manville as consulting engineer for this great traction scheme.

Mr. MANVILLE, in replying, said: Mr. Yabbicom's question is one which I have very often asked myself. I do not really think between the span wire system and the rigid attachment on a bracket there is anything to choose in the way of safety. I think both are equally safe, but there is no doubt that the span wire system, apart from any æsthetic consideration, is the best in working, because it forms the easiest passage for the trolley wheel to pass over, and there are no hard points along it at all. I had the privilege of putting up the first electric system at Bristol, which was a bracket system with rigid attachment, but that was the first electric tramway put up in England. It is a subject which ought to be dealt with bit by bit and at great length, and not be crowded into a few words.

WEAR OF ROADS BY HORSE HAULAGE AND MOTOR TRAFFIC.

By W. WORBY BEAUMONT, M. Inst. C.E.

The old adage that time is money has always been looked upon as a brief statement of a broad fact, but until comparatively recent times, it has not been broadly recognised that time, which might be saved by modern expedients and was not saved, was money in sight thrown away.

In no matter is this more true than with respect to time lost in the transit of either men or things, and it has not been possible to realise the further truth that the physical fatigue of intelligent men by slow and uncomfortable modes of transport is a waste of money-earning capacity, without any even indirect advantages.

To avoid these losses, good roads and ample means of easy and quick transport upon them are among the first of all necessities.

The title given to the short paper the Author has the honour of placing before you is "Points as to wear on roads caused respectively by horse haulage and motor traffic." The Author does not, however, intend to occupy much of your time on those questions upon which your personal practical experience is so much more extensive than his own.

Since the days when Telford, and MacNeill his resident engineer (afterwards Sir John MacNeill) and others gave so much attention to the subject, it has been recognised that the wear of roads by horses' shoes is greater than the wear of roads by the wheels the horses hauled.

It was shown by the observations of MacNeill, that the wear by the horses hauling heavy vehicles and heavy loads was less than that by the horses hauling the lighter loads at the higher speeds. The relative proportions of the wear under these different classes of traffic were fully stated in evidence before the Select Committee on Steam Carriages in 1831, and very

little has transpired since to alter the qualitative value of the conclusions then announced, although road and vehicle improvements have added to the number of exceptions to their quantitative value. See report of Select Committee in Gordon's 'Elemental Locomotion,' pp. 131 *et seq.*

The causes of road-wear were summarised for a general statement, and may be collated as follows:—

GENERAL RESULTS OF OBSERVATIONS OF CAUSES OF ROAD WEAR AND DETERIORATION.

Kind of Vehicle and Load.	Wear due to Atmospheric causes.	Wear due to Wheels.	Wear due to Horses' Feet.
	per cent.	per cent.	per cent.
London and Birmingham Coaches—Weight, 16 to 18 cwt. empty; loaded, 45 cwt. Speed, 8 to 12 miles per hour. . . .	20	20	60
Wagons—Weight, 25 cwt.; loaded, 92 cwt. Speed, 3 miles per hour	20	35·5	44·5

These figures can only be taken as roughly approximate because the character of the roads in different places and the gradients make any approach to accuracy impossible. It may however be conceded that the relative proportions on average country roads with some exceptions remain much the same to-day, as the widths of wheels remain about the same for the lighter vehicles, although on the whole they are narrower for the heavy vehicles generally classed as wagons.

Anyone who has observed the effects of the passage of different kinds of vehicles along, say, the road between Southall and Oxford, particularly on the Dashwood and Ashton Hills, can obtain very good evidence of the nature of the wear due to the different causes which obtain with horse-hauled and motor-propelled vehicles. It may also be seen everywhere in and near London where the macadam roads are very bad, especially in the West End parks (not the tree-covered), where the traffic is of light vehicles and numerous horses; and it will be seen that the figures and statements of Telford, MacNeill, McAdam and others are of value to-day.

The great departures from the general applicability of these

figures arise where the roads are particularly well made and maintained.

On the best roads it may be said that the injurious effect of atmospheric changes is less, that the wear due to the wheels is less, and that the wear due to horses' shoes is greater than in the preceding table, especially with the lighter high-speed vehicles.

Where roads are made with metalling of small size and with a minimum of binding materials, the irregularities in compactness are less than in roads made with large metalling, the almost regular recurrence of looser and tighter patches due to the method of compacting by rollers is less, and the effect of the hammering by horses' feet between the harder or more compacted recurrent spots is less. On most roads, however, the effect of the hammering and scrabbing by horses' shoes is to loosen and remove most where it is most easily moved. The hollows are thus rapidly made more hollow, iron-tired wheels at high speeds hammer their edges or boundaries and so enlarge them, and water collects. Once the formation of a saucer hollow has commenced it soon becomes a dish, and every element of wear, tear and deterioration becomes cumulative. The surface becomes worse and worse, until it is a pain and mortification to have to use them for anything but the heavy slow traffic of three miles an hour. The wear and tear of every vehicle of speeds of eight miles per hour and upwards is enormous, as compared with what it need be. Even with the large wheels of hansom cabs it requires the patience of Job to endure the jolting, and the jobmasters have to keep their best language for expressions of reverence of their repair bills.

To gain anything like a true knowledge of the effect of the average bad road surface in the destruction of vehicles, it is only necessary to take a run in a light motor carriage with, say, 30-inch wheels and solid rubber tires at, say, 12 miles an hour. It may be just possible to retain one's dental integrity at this speed, but at anything like a sufficient speed to avoid a charge of wasting time on the road, it would be necessary to have spine and teeth of indiarubber. A motor carriage makes an excellent road surface inspector. It experiences all the badness —and says nothing.

Now it is better roads we must have for the higher speeds that modern times demand;—more men and for a time more money at the disposal of our engineers and surveyors.

Usually very little is done of the nature of effective mending. It is sometimes said that mending and patching are of no use. Mending badly done under incompetent teaching and supervision is of no use, but with roads well made in the first instance, and then kept under inspection by intelligent men with sufficient careful workmen under them and suitable tools and materials for making timely corrections and repairs, mending should be of great economic value. There is little use in merely tipping or spreading new metal in the hollows.

Roads should be under inspection as constant as that of the permanent-way of a railway, and each district superintendent should be as responsible for the perfect keeping of his length of road as is the district superintendent on a main line of railway.

All this means money, and, in the first instance, rather more money than usual; but the Author is quite sure that in a short time such thoroughly kept roads would cost less than the making and remaking of badly kept roads. Even if it cost a little more everybody would reap the benefit of it through the lessened wear and tear of every vehicle on the roads and the greater comfort and pleasure.

It would be to no purpose to say that things would be much better were it not for the wear by horses' shoes. Horses on the roads and streets of the kingdom may be reckoned in millions, and it will be a very long time before the seven figures necessary to represent this quantity are reduced to six figures.

The growth of the use of motor vehicles will, however, gradually though slowly do this. Meanwhile the indications of modern changes in the type of horse and vehicle used for transport of every-day merchandise should be noted. Time of delivery, in other words speed, has become the dominant factor, and hence the trotting cart-horse and the light high-speed van with narrow tires have grown more rapidly than any other type, and the heavy slow-speed van for such work is but little used. It is these light vans, carrying from 1 to 1½ tons on 2-inch tires, and with trotting horses, that do more mischief on the roads than any other class, unless it be omnibuses. The same loads at half the speed would do very little damage, except at starting places and on hills. It is the speed that wears the vehicles, and therefore the roads. The speed, however, must be had for all but the very heavy traffic.

To make this possible we must have (1) well-made and

well-maintained roads; (2) width of tires (when metal) ample in proportion to load on them. And as far as practicable, encouragement should be given to (1) the use of rubber tires generally; (2) the use of light-load motor vehicles, the earning capacity of which is ensured by despatch in transit, and not by weight of load.

The endurance of materials fixes limits of either speed or load. We may have high speed and light load, or heavy load and low speed. We cannot have both on common roads as made and kept now, but both speed and load may be increased upon really good road surfaces.

It is not, however, in this connection necessary to consider continuous heavy traffic on any definite line as between two or more towns. When the quantities of materials to be carried become large and constant, or nearly so, such as from 500 to 1000 tons per week, then the conditions which require a railway—or at least a tramway or plateway—have been reached. Such quantities are best off the macadam or any other kind of highway, however made, and in fact could not be carried by them on heavy metal-tired vehicles.

Considering then only the lighter class of motor vehicles, such as those which carry from one to two tons, at speeds which may meet modern requirements, it may be confidently expected that the wear of the roads by them will be from 20 to 40 per cent. less than by horse-hauled vehicles, and that it will, therefore, pay to spend more money at first in following out the best possible construction and afterwards in maintaining a trained body of road repairers constantly at work so that these vehicles may be profitably used.

To the lessening of the cost of road upkeep has to be added the lessened cost of scavenging, which will also be very great, even if for the moment the cost of removing the horse-dung from our streets is not included, or the hygienic value of its absence not considered.*

In concluding this brief paper on a subject which want of time robs of systematic treatment, the Author wishes to repeat that there is nothing on which the County Councils of this kingdom can spend money more profitably than on the proper construction and effective maintenance of good roads. Such

* Sir Arthur Arnold recently stated that as much as 4 tons per mile per day was removed from some of the London streets.

roads would render them independent of town and suburban tramways, remove a dangerous and obstructive anachronism and increase the traffic-carrying capacity of the road.

DISCUSSION.

Mr. R. J. Thomas: I am interested in the paper read, because I differ *in toto* from many of the statements it contains; more particularly the assertion that horses' hoofs always do more damage to roads than the wheels of the vehicles they draw, and that an example of this may be seen on the road between Southall and Oxford. It is the exception, rather than the rule, to see pathways of roads more worn than wheel tracks, and as I have had the Buckinghamshire portion of the Southall and Oxford road under my care for the past eleven years, I am quite confident that Mr. Beaumont cannot show me any portion of this specifically-named road where horses' hoofs have worn it more than wheels. Judging from this paper, a wonderful impression prevails in some quarters that nothing has been done of recent years to improve roads. I combat the statement entirely. Another assertion of Mr. Beaumont's was, that the responsible authorities would not provide sufficient funds for properly repairing roads. For the past eleven years my County Council have given me full rope, and provided whatever funds I recommended; therefore, if anything is wrong with the Buckinghamshire main roads, the fault is mine and not my Council's. With reference to the statement that only casual labour of the most ignorant class is employed upon roads, I may say that at least 50 per cent. of my roadmen have worked regularly for me during the past ten years, they are not loafers and idlers picked up at street corners, but are quite as intelligent a class as the bricklayer type referred to by the Author, and do their work quite as well. In reponse to your request, Mr. President, I propose a vote of thanks to Mr. Beaumont for his paper.

Mr. R. A. MacBrair: I would like to call attention to two statements made by the Author of the paper. "A motor carriage makes an excellent road surface inspector. It experiences all the badness—and says nothing." "Considering then only the lighter class of motor vehicles, such as those which carry from 1 to 2 tons at speeds which may meet modern requirements, it

may be confidently expected that the wear of the roads by them will be from 20 to 40 per cent. less than by horse hauled vehicles, and that it will therefore pay to spend more money at first in following out the best possible construction, and afterwards in maintaining a trained body of road repairers constantly at work, so that these vehicles may be profitably used." About a year ago a private company started in Lincoln running motor vehicles. I carefully noticed some of the roads they went over, and found that the cars were not an unmitigated blessing. The rubber tyres have a peculiar effect upon some of the roads, giving them a corduroy appearance. The cars also have an unpleasant habit of swishing the mud and any liquids on the road on to the footpath. The rubber tyres have a kind of suctional action, drawing the detritus and moisture out of the roads, which cannot be said to be a good thing. In fact, many people in Lincoln would be very glad to see motor vehicles taken off the roads altogether.

Mr. J. P. Norrington: Although Mr. Beaumont seems to have been rather unfortunate in referring to a particular road, I should like to say that my experience had been that the general action of local authorities was as described by Mr. Beaumont. I am pleased to hear that Mr. Thomas has full rope given to him as to expenditure on his roads, but it is not so generally—at least, so I think. An authority will repair a road and then allow it to go for four or five years, until it gets into a shocking condition. In London generally, there is not that regular repair of the roads which should take place. Wood paving is allowed to go for six, eight or ten years without anything being spent on repairs, and then the whole road has to be taken up and relaid. I hope for and expect a large substitution of motor traffic for horse traffic on the roads.

Mr. E. P. Hooley: I have very great pleasure in adding my testimony to what Mr. Thomas has said. I cannot possibly congratulate the Author of the paper, because I have not carefully read it for one thing, but I certainly cannot congratulate him upon what I have heard of the speeches on the paper. I am one of those unfortunate men who have had some slight training in road work, and if my knowledge of the work does not take me further than the Author of this paper, it would be a bad look-out for those who are under me. A more unkind statement than that the authority cuts down the expenditure on the roads,

merely for the sake of cutting down, without consideration of the condition of the roads, I have never heard. It is simply because the authorities have not the money to waste in the way in which automobilists wish it to be wasted. We do the best with the money at our disposal to keep the roads in proper order. I think many of those who use the roads ought to thank the Almighty that they live now instead of in former times. This constant criticism of road making by persons who know little about it actually irritates me—and that is saying a great deal. You read in the newspaper that Mr. Jones, who is a fishmonger or other tradesman in his own country, has been for a ride of 1000 miles in a motor car, and that tradesman immediately proceeds to tell you how you ought to make roads. Why, County Surveyors often travel a thousand miles in a month. I think the Author must have always lived in London and never been out of London. The roads are bad in London I know, but if Mr. Beaumont will come into the country we will show him some good roads, and perhaps improve his road knowledge.

Mr. J. P. Barber: Mr. Hooley is irritated by Mr. Beaumont's criticism of roads, but is not irritated by the men he (Mr. Hooley) employs on the roads in Nottinghamshire. I am unfortunately irritated by my men in London, and I am bound to say I quite agree with Mr. Beaumont that in very many cases we are unable to get men who can repair the roads with the same skill and intelligence that the old roadmen in the country exercise to the present day. I have, over and over again, when passing over a country road, and seeing the skilful way in which the men repair a road and trim up the bad places, wished that I could have such intelligent men to repair the roads in my district in London. I have the greatest difficulty in selecting six men from 200 who can spread a load of broken stone efficiently and economically. We seem to get men in London who have failed at nearly everything else, and who appear to think that all they have to do is to come and help the borough engineer do his work. And apparently nearly every philanthropic person in London has a great number of men in whom he is interested, and for whom, when they are out of work (and they nearly always are out of work, for nobody keeps them long), the borough engineer can provide unlimited work. These men are the most unskilled workmen that could possibly be employed. With this condition of things, it is not

surprising that we are unable to produce the same results in maintaining and repairing the roads as can be seen in the country districts, where the work is done by the old country roadmen. It is a most difficult thing to get a workman to take any interest in his work, let alone show any intelligence. Unfortunately, the borough engineer cannot use the language he needs in order to express his annoyance at the stupidity of his men and their inability to carry out his instructions. Only this week I gave the clearest and most specific instructions as to the way in which certain portions of a macadam road were to be repaired, but on going to the road I found the men simply playing the fool. That is a very mild expression. I should have liked to use stronger language, but unfortunately one cannot do that. It is exceedingly annoying to have to rely upon the unskilled men whom we have to do our work in London. We cannot be overlooking all the men and, unfortunately, we do not seem to get the men who can be educated to the work. I wish Mr. Thomas and Mr. Hooley would draft some of the intelligent old roadmen they have in the country into London, because they would not be long in finding situations. I do not find the men employed on the roads in the country are unskilled men. I have noticed some of the old men who were no longer able to pick up a road or spread material, trim up the turf and shape the margins of the roads into most beautiful curves. If I had the work to do in London I should have to send one of my staff with a theodolite to mark out the curves and see the work done. I hope Mr. Beaumont will not go away and think there is no one here who does not lament the decadence of the skill and intelligence of the roadmen. I wish we could get in London some of the skill and intelligence which seems to abide in the country.

Mr. J. M. KNIGHT: I also appreciate the difficulty of getting good men to work on the roads, and when I want such men I go to Kent to find them.

Mr. J. PATON: Mr. Barber has confirmed Mr. Hooley's remarks in every respect. I totally disagree with Mr. Beaumont in his wholesale condemnation of the way in which the local authorities keep up macadam roads. I cannot help feeling that his experience must be exclusively a London experience. The bad condition of the roads in London is due to the very cause of which he speaks—the use of india-rubber-

tyred motor vehicles. The india-rubber tyres on the wheels of these vehicles tend to disintegrate the macadam, with the result of bad roads. Mr. Beaumont has dealt with generalities all through his paper. He has accused the local authorities of parsimony, but he has given no evidence in support of his accusation. Then he says the art of road-making has been lost; an assertion with which I totally disagree, for if you will come into almost any county you will find the roads in better condition than ever before. Therefore, I think his experience of the condition of the roads must be limited in its extent. In my experience there are very few county councils or borough councils who cut down their estimates to such an extent as to spoil their roads. I have had twenty years' experience of road making, and I can say that the roads are better made and maintained now than they were twenty years, or even ten years, ago.

The PRESIDENT: The County Surveyors who have spoken are model men and they are serving model Authorities. We all agree that the standard of road making should be raised as much as possible in order that the whole country should derive the fullest advantage from automobilism.

Mr. BEAUMONT, in replying to the discussion, said: While thanking you for the "very hearty" vote of thanks suggested by Mr. Thomas, I cannot help admitting that I am exceedingly pleased at the way in which this paper has been received. If everything I had said had been received as all a matter of course, it would have been obvious it was not necessary to say anything. With regard to Mr. Thomas' remarks, I have not said that nothing has been done to improve the roads. I said that even suppose the wear caused by horses was no more than the wear by the vehicles, it would still be a large part of the whole, and this at least would be taken away by the use of vehicles without horses. As to Mr. Thomas' roads, I admit I would like nothing better than that I should, as he suggested, put my finger on the right spot. I am afraid, however, that a great many more would be offended, if I told you where we found the roads were good and where we found they were bad.

Mr. THOMAS: I have not said a word about the condition of my roads, but prefer to leave that to my council and the ratepayers who use and pay for the roads.

Mr. BEAUMONT: We have found excellent roads in parts of

Cambridge, and excellent roads incapable of improvement between Coventry and St. Albans. I am the last man to say no improvement has been made. The modern methods or means are infinite improvements upon the old methods. One speaker, Mr. Hooley, said the expenditure on roads was not cut down, there was no parsimony about it, and then went on to say that the authorities had not the money given them to waste as automobilists would have them waste it. It appears to me he has entirely given the case away, or at any rate given it into my hands. Mr. Thomas says his council give him full rope, and I shall have pleasure when in Buckingham of seeing which of his roads are good and which bad. Where the macadam roads are so made that the rubber tyres suck out the mud and throw it from between the stones, on to the pavement, as Mr. MacBrair said, I think there might be another view expressed with regard to those roads. When Mr. Hooley speaks of my having only a London experience, it is probably known to many, even if not to him, that I have travelled all over the country and make many thousands of miles a year on motor vehicles, so that I have some information as to where roads are good or bad. Mr. Barber, who is known to you all as one of great experience in all matters relating to road making, and therefore knows what he is talking about, has spoken of the difficulty of getting good men, and the impossibility of getting them to spread the material intelligently. Mr. Barber has also spoken of the intelligent way in which some of the old country roadmen not only spread the material, but the way in which they put the material—which is a different thing. It is more in the nature of putting the material in such a way that it will stop where put, that we want intelligent men on the roads. As to London roads, it would appear from the remarks of some speakers that London must be nearly 200 miles in diameter, if I may judge from a large percentage of the roads running into London. Mr. Paton spoke of my wholesale condemnation of the roads. I admit they are excellent in some parts, but they are execrable in others. I do not wish to point to anyone as being a greater culprit than anyone else. I do not speak of road making as a lost art. If ever it was known how to make a road and known how to maintain it, it is to-day as compared with any other time. You may know how to do it, but it requires money and men to carry out your knowledge, and that

is what you have not got for at least 60 per cent. of the whole of the roads of this country. Having said that, I am willing to admit that the roads are generally better now than they were twenty years ago. But we want them *everywhere* better than they were twenty years ago. If anyone challenges what I say about the roads I shall be pleased to take him on a motor carriage and let him see what will happen when that carriage goes more than a crawl. He will then get an idea of the vileness of the surface of the roads. One of the speakers has spoken of the necessity of early attention to the roads after they have been made. This is one of the greatest of the needs at the present time. We want more of the stitch in time, the removal of the incipient faults. We want the men as continuously on the roads at the little work as they are on the permanent way of a railway, and that it can be done there is not the slightest doubt. In conclusion, I will again say, that as a whole the roads are better than ever before, that everybody knows all about road making, but comparatively few exercise their knowledge, and that those who do, only want the men and the money to put the best knowledge into practice and ultimately to save money by the initial expenditure.

NOTES OF EXPERIMENTS MADE ON THE PURIFICATION OF SEWAGE BY MEANS OF STODDART'S IMPROVED SEWAGE FILTER, AT KNOWLE, BRISTOL.

By T. H. YABBICOM, M. Inst. C.E., City Engineer.

In the year 1897 Parliament sanctioned a considerable extension of the area of the City and County of Bristol by the inclusion of the whole or parts of the surrounding districts until then controlled by Urban District or Parish Councils; and among the portions added to the City was one on the extreme south that until a few years ago had been principally occupied by agricultural land and a few isolated cottages, but more recently attracted the attention of the speculative builder; and would have done so sooner had the means of drainage been more simple. A watershed runs across the district from east to west; so that, while the northern portion naturally drains towards the valley of the Avon, the surface water of a small portion in the south of the watershed drains into a brook running through a district outside the extended City boundary. At the date of the inclusion of this area, known as Upper Knowle, within the City, no attempt had been made to deal with the sewage from the houses then built, each house or group of houses having its own cesspool, which being constructed in the lias formation, quickly filled, the overflow discharging into a ditch at the side of the road, and eventually finding its way into our neighbours' brook. Here were all the elements necessary for outbreaks of an infectious disease and righteous indignation on the part of the members of the neighbouring authority. The latter were not less clamorous because the area had been carved out of their district and the then insanitary state of things was the result of their previous neglect.

Until 1897 the whole of the drainage of Bristol was discharged by gravitation into a tidal river without treatment, and it will be possible to connect the sewage of Upper Knowle with the general Bristol system, either by a deep tunnel through the hill or by a more circuitous route round it. The latter would be the practical method, but would involve passing for a short length through our neighbours' district with the usual application to the Local Government Board and consequent delays. The writer, therefore, decided to adopt at once temporary works for the treatment of the sewage from this small area and obtained from the tenant of a field, suitably situated, leave to construct tanks; he also recommended his council to lay sewers in the principal roads, without waiting for the formalities necessary to obtain a loan, that should be available for the drainage of the district in the event of the sewers being connected with the general system.

Operations were commenced in 1898, and at that date less than 60 houses had been constructed. While the sewers were being laid the small area in the field was prepared for the reception of the sewage by the construction of a settling tank having a cubical capacity of 5625 gallons. This tank was built of cement concrete and covered with a flat roof. The tank effluent was conducted to a series of three filter beds, each having an area of 40 superficial yards and a depth of 3 feet, the filtering medium being clinker from the refuse destructor broken to graduated sizes. The effluent was distributed over the surface by channel pipes, the use of the filters being intermittent, and the filtrate conducted to the watercourse in our neighbours' field. Sewage was first passed into these temporary works in April 1899.

One of the early effects of the construction of sewers, and consequent extinction of cesspools, was an impetus to building operations to such an extent that before the works came into operation the number of houses previously built had been doubled, and it was evident that more tank area would be required. During the summer of 1899, the writer was much engaged on the preparation of plans for a main drainage scheme which should include sewers for the Upper Knowle district, and he was therefore anxious not to spend a considerable amount of money upon works that he hoped would be only a temporary necessity. However, in August and September 1899, the

neighbouring council wrote letters stating that their brook was being polluted by the effluent from the works, and on analysis being made by the City Analyst, the results were found to be as stated below :—

ANALYSIS OF SEWAGE EFFLUENTS, AUGUST 15, 1899.

Results in parts per 100,000.

	A Crude sewage.	B Tank effluent.	C Effluent from filter bed.
Saline ammonia	8·0	4·5	3·1
Albuminoid ammonia	·57	·36	·23
Nitrates	..	..	..
Nitrites	strong trace	strong trace	..
Chlorine as chloride	7·85	5·28	5·42
Oxygen absorbed in 15 minutes	1·87	1·88	1·08
" " 4 hours	3·68	2·6	1·92
Total dissolved solids	72·85	57·14	52·85
Suspended solids—organic and ortutile	47·85	18·0	23·42
" " fixed	7·43	24·42	6·0

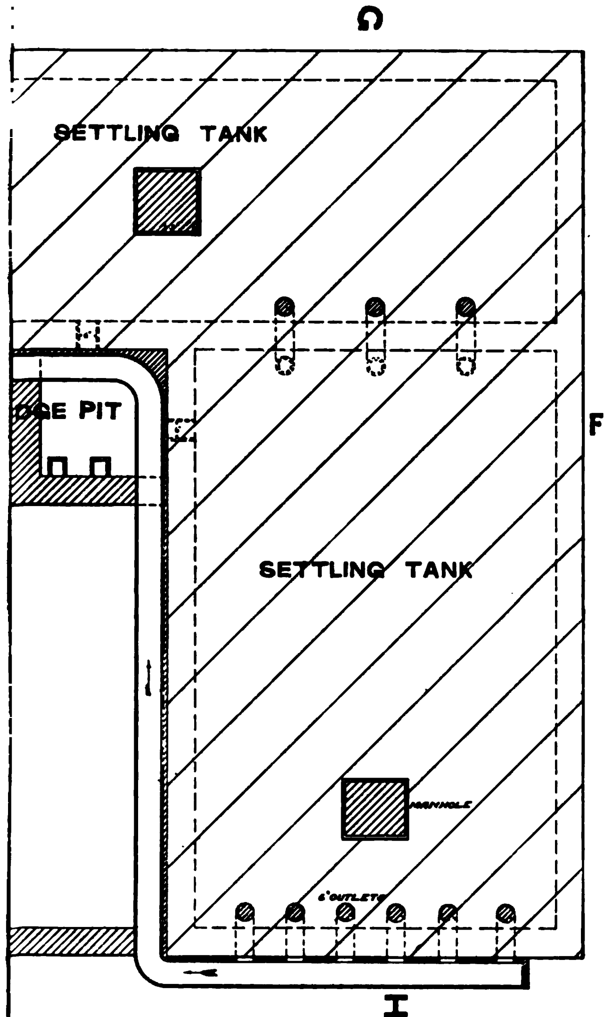
ANALYSIS OF SEWAGE EFFLUENTS, ETC., SEPTEMBER 8, 1899.

Results expressed in parts per 100,000.

	A Crude sewage.	B Tank effluent.	C Effluent from filter bed.
Saline ammonia	4·5	4·8	·18
Albuminoid ammonia	·49	·32	·17
Nitrates	..	..	..
Nitrites	..	..	..
Oxygen absorbed in 15 minutes	1·24	1·0	·42
" " 4 hours	2·972	2·28	·88
Chlorine as chloride	5·85	6·42	5·0
Total dissolved solids	70·0	62·8	55·7
Suspended solids—organic and ortutile	7·85	4·71	1·85
" " fixed	2·85	3·42	·285
Physical characters	Turbid sewage odour	Turbid sewage odour	Turbid; rank odour not distinctly of sewage.

Of course this was not satisfactory, and it appeared that the tank and filters were insufficiently large to deal in a satisfactory manner with the quantity of sewage flowing to them. A

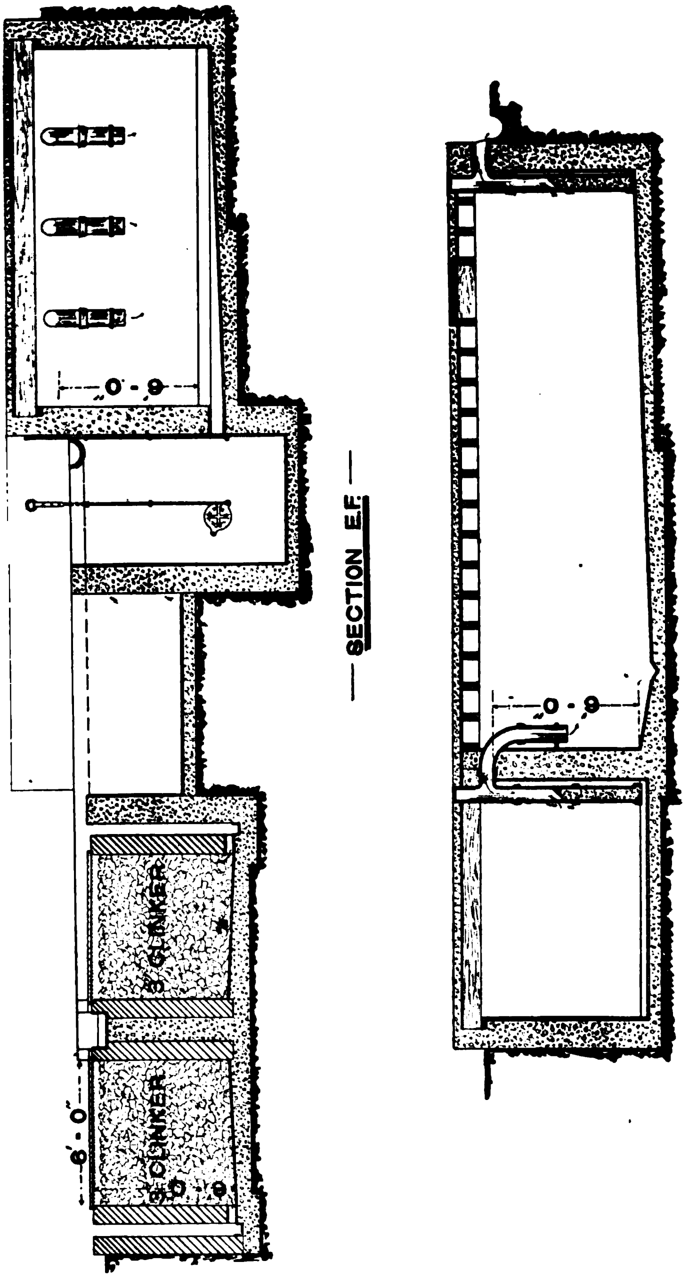
PLATE I



ANKS

PLAN OF TANKS.

PLATE II.



SECTIONS OF TANKS AND FILTER BEDS.

Scale, 1/8 in. to 1 ft.

request for more land for extension of the works was promptly met by a refusal from the owner of the soil, influenced by the neighbouring council, who had been antagonistic to the proceedings of the City, and who about this time applied for an injunction to restrain their continuance.

Under these circumstances the writer consulted Mr. F. W. Stoddart, the City Analyst, who stated that in his opinion a better effluent would be obtained on the restricted premises by enlarging the size of the settling tank, decreasing the area but increasing the depth of the filtering material, and by using an improved method of distributing the tank effluent over the surface of the filter. The dry-weather flow was at that date (October 1899) estimated at 25,000 gallons of domestic sewage daily.

The covered tank was increased so as to hold 19,000 gallons; a filter, having an area of 30 square yards and a depth of 6 feet, was made of rough clinkers of not less than 2½-inch gauge, and the tank effluent was distributed over the surface of the clinker by a contrivance invented by Mr. Stoddart, which is best described in his own words, illustrated by the accompanying drawings.

"The distributor consists of a number of narrow gutters arranged at right angles to the supply channel, and resting upon its margin and upon suitable support at the distant end. Each section of the distributor abuts against a casting embedded in the margin of the supply channel, so arranged that the tank effluent, on flowing over the margins of the channels, passes into the gutters of the distributor. Along the lowest part of the under surface of each gutter is placed a series of vertical points.

"The sewage or tank effluent, entering the gutters by way of the supply channel, flows over the margins, and on reaching the under surface, falls from each of the vertical points in a series of fine drops.

"It will be seen that there are no fine perforations to become clogged, and that the action of the distributor does not in the least depend upon the subdivision of the sewage by fine apertures or tubes, but that there is a perfectly free passage for the sewage from the supply channel to the filter itself. There are also no moving parts, or indeed anything that by any stretch of the imagination can be considered likely to get out of order."

The new process came into operation on November 21, 1899, and it was soon found that the estimated amount of sewage would be exceeded. In March 1900, it was reported that the daily gaugings had never fallen below 39,000 gallons, and had been at times much greater; indeed, for a short time on March 15, the flow was at the rate of 201,000 gallons per day.

The tank, therefore, only held a 12-hours instead of a 24-hours supply, and the filter had to pass at least 1300 gallons per square yard per day. Under these circumstances very good results were not to be expected, but samples taken on February 13, 1900, indicated an improvement in the filtrate, as shown by the following analysis:—

	Parts per 100,000.
Saline ammonia	·65
Albuminoid ammonia	·07
Nitrogen as nitrates and nitrites	1·23
Chlorine as chlorides	4·3
Oxygen absorbed in 4 hours at 80° F.	·52

A further extension of the settling tank was made in July 1900 to a capacity of 26,000 gallons.

The neighbouring council commenced proceedings, asking for an injunction, and the case was heard on July 26, 1900. After hearing the evidence of the applicants and viewing the works, the learned judge decided to adjourn the case over the long vacation, and then to hear the defence, but before the case came on for a second hearing, the applicants withdrew their assertions, and there has been no further trouble.

During the last winter the filter continued to do satisfactory work, and proved that the maintenance of a very low temperature had no influence upon its action.

At the present time (June 1901) the sewage from a population of about 900 persons enters the tank and filter, and the gaugings taken show a minimum dry-weather flow equal to 26 gallons per head per day.

The amount of chlorides in Bristol Water Company's water averages 1·5 parts per 100,000.

During the past twelve months the minimum dry-weather flow has been 20,000 gallons, and the maximum 300,000 gallons, during 24 hours, equal to about 700 and 10,000 gallons respectively per square yard of filter.

Mr. Stoddart states that the average composition of the filtrate in 1900 was as follows:—

Parts per 100,000.

Saline ammonia	1·738
Albuminoid ammonia	·12
Nitric nitrogen	1·87
Chlorine	7·20
Oxygen absorbed in 4 hours at 80° F.	1·04

The average rate of flow during the year was 1550 gallons per 24 hours, although Mr. Stoddart estimates that the area of the filter should be such that each superficial yard should not be required to deal with more than 1200 gallons per 24 hours. The increased quantity has, however, been passed through without any detriment to the works.

The last analysis that the writer is able to include in these notes is from samples taken on May 28, 1901, when there had been practically no rain for fourteen days. On that day the flow was 46,800 gallons in 24 hours, equal to an average of 1560 gallons to each square yard of filter.

Parts per 100,000.

	Tank effluent.	Filtrate.
Saline ammonia	3·60	2·76
Albuminoid ammonia	·40	·145
Nitrogen as nitrates and nitrites	nil	·67
Chlorine as chlorides	5·30	5·20
Oxygen absorbed in 4 hours at 80° F...	3·05	1·35

Incubator test satisfactory.

The Author has brought together these notes of a practical experiment, not because he wishes to advocate any particular system of sewage purification, but because all information must be useful. He sincerely hopes that before a very long time has elapsed he may have succeeded in getting such gravitation sewers constructed as may render unnecessary any works of treatment whatever.

The Author has much pleasure in acknowledging the very great assistance he has received in connection with these works from the deputy City Engineer, Mr. W. J. Steele Assoc. M. Inst. C.E., and the District Surveyor, Mr. E. W. Lashmore, Assoc. M. Inst. C.E., the latter having had charge of their construction and maintenance.

DISCUSSION.

Mr. G. W. Lacey: I have much pleasure in proposing a vote of thanks to Mr. Yabbicom for his paper. The notes on the Stoddart filter, so far as they go, are interesting, but I think some further information might be given which would render the paper a little more complete, and elucidate the questions which I should like to put to Mr. Yabbicom. I gather from the paper that this new process was commenced in November 1899, and consists as far as the filter beds are concerned of one filter bed only. I should like to know whether that one filter bed has been in continuous use ever since without any rest. I notice also that the flow of the tank effluent through the filter is continuous and not intermittent, and I would like to know the original capacity of the filter and whether it has decreased at all during the lengthened period it has been working continuously. I do not know whether the tank acts as a septic tank; if it does, I would like to know what amount of deposit he has had in the tank and whether he has had to clear out the deposit. Mr. Yabbicom makes no reference to the original filtering material, but I gather that the gauge was rather smaller than in the new filter, which is 2½ inches. So far as the results are concerned I do not know that they are very striking. The rate of flow to the filter is no doubt very large, and appears to account for the results given. He has not given in the last of the analyses the composition of the sewage. If you take the sewage analysis of August 1899 as a basis, it would appear to show a purification of only about .75 per cent. Though the quantity of albuminoid ammonia is not very great, the percentage of purification does not come up to what is obtained in several systems. The last analysis taken appears to show that the filter is not working so well as it did, and that the rate through it is in excess of what it ought to be. Whether Mr. Stoddart's distributor can be applied equally well to a large filter is open to question. If you have a filter 100 feet in diameter it must be a costly matter. Perhaps Mr. Yabbicom will include the cost in the paper, as it appears it might be, if worked on a large scale, a difficult and expensive process, though I quite admit

that the system of distributing the effluent over the filter in the form of rain or shower must be an advantage, as it takes down to the filter bed a considerable quantity of oxygen, which has a beneficial effect on the bed.

Mr. R. A. MacBrair: In seconding the vote of thanks I should like to emphasise what Mr. Lacey has said as to work of this filter. We surely do not consider that 1·35 of oxygen absorbed in four hours is a first rate effluent. Is not the standard in the north 1? The rate of flow through the filter seems very great; it is between seven and eight million gallons per acre daily. This rate may be obtained in a laboratory or on a small scale, but in large practical works I doubt if you can get that flow.

Mr. A. Creer: In supporting the vote of thanks I should like to make some comments on certain details. I notice Mr. Yabbicom says that for a short time on March 15 the flow was at the rate of 201,000 gallons, which works out at the rate of 223 gallons per head per day, or 6900 gallons per square yard of filter. If the analysis given was taken under those circumstances, I do not think that Mr. Stoddart can be congratulated upon the result. It would be very interesting to know what quantity was passing through the filter when this first analysis was taken. Then again it is stated that "during the last winter the filter continued to do satisfactory work, and proved that the maintenance of a very low temperature had no influence on its action." That is contrary to the previous experience of all who have studied the question. It has generally been maintained that a temperature of at least 42° is necessary for the bacterial action of the filter; this point, however, would have been cleared up if the results obtained during the winter had been set out in the paper. This would have enabled us to form an opinion as to whether the results were sufficiently satisfactory to comply with the requirements of the various River Boards. It is stated that the maximum flow in twenty-four hours has been 300,000 gallons, or equal to 333 gallons per head per day, or fifteen volumes of the dry weather flow, a state of dilution the Local Government Board would allow to flow into a stream without treatment; or it would mean that the contents of the covered tank into which the sewage flows would have to be completely changed eleven times in the twenty-four hours. Therefore, it would be impossible for any septic action to take place in the tank. During the last two

years I, like other engineers, have been carrying out a number of experiments, more particularly with reference to avoiding the requirements of the Local Government Board as to land. As to those experiments which have been made, I should like to call attention to one that has been essentially satisfactory: that result has been brought about with the use of an open septic tank with a continuous filtration through 6 feet of filtering material. In the case of the open tank, for six months we were unable to get a scum upon it, but the results were exceedingly good. In twelve months working we have never got below the standard set by the West Riding River Board, viz., 1 grain per gallon oxygen absorbed, and 0·1 grain per gallon albuminoid ammonia. Taking the average of twenty-five analyses the oxygen absorbed in four hours was 0·670, the standard being 1·0; the albuminoid ammonia was 0·066, the standard being 0·1. This is in parts per hundred thousand. Another peculiar thing is that out of thirty-three analyses there was an average of 7·22 parts per 100,000 of calcium nitrate, a result I have not known obtained in any other experiment, or have heard or read of except in laboratory experiments.

Mr. H. G. Whyatt: I should like to support this vote of thanks because I know of some sewage experiments conducted on the lines of Mr. Stoddart and this installation as carried out by Mr. Yabbicom. That was at Salford, where I held the position of deputy for over ten years. Mr. Corbett put down experimental filters, some solid from top to bottom without intermediate aërating floors, and some with intermediate aërating floors. Mr. Corbett described these filters at the District Meeting held at Stafford, and reported in vol. xxiii. page 253. He originally adopted but afterwards abandoned the method of allowing the sewage to drop on to the filter, very much on Mr. Stoddart's lines. First he had V-shaped troughs with small holes bored in the bottom which very soon choked up; then he cut niches down the side, and the sewage ran through and along the bottom until it found a point, and dropped in a continuous stream exactly like Mr. Stoddart's. Then he tried perforated pipes which were a success. In these experiments of Mr. Yabbicom the sewage drops down in one continuous stream in the same place. Mr. Corbett's arrangement was to use a cast-iron pipe 4 inches in diameter, and on the top of that put sprinklers with two holes facing each other; the sewage

came through the holes in two jets, which impinged upon each other and spread in the form of spray, so that no two drops fall consecutively on the same spot.* This has been entirely successful, and the Salford Corporation has nearly completed the construction of five acres of filters, the sewage being applied in the form of spray by these sprinklers.

Mr. H. SHAW: I feel that I must take exception to Mr. Yabbicom's statement that "there are no moving parts, or indeed anything that by any stretch of the imagination can be considered likely to get out of order." At Ilford, for example, the trays in use on the experimental works which are being operated for the Royal Commission on Sewage Disposal have so buckled that only about one-third of the area of each tray actually came into use, with the result that we have been obliged to reduce the flow to a third of the amount for which the filters have been designed. Mr. Stoddart is now constructing new trays which I trust will give better results than the present ones. I would like to be informed whether the variation of temperature has any effect on the trays.

Mr. W. J. DIBDIN: It is most interesting and instructive to myself to hear this paper, and I do think that it is a matter of congratulation, not only to the Members of the Association who spend their lives in the public service and in studying how that public service may best be served, but to the ratepayers, that any and every method of applying the most economical method we have at the present time to the bacterial process of the purification of sewage should be thoroughly discussed and put to the test. I think in this connection Mr. Stoddart has done some good work. I cannot for the moment quite grasp where the central point in this matter comes in contrast with some other scheme. I do not wish to speak in criticism, but to put the facts as they present themselves to my mind. For instance, I find according to the description that we have something in the nature of a tank that may be called a septic tank, or if the rate of flow through that tank be too rapid for an anaerobic tank, then we may call it a detritus tank, in which the coarser solid matters are kept back from the sewage; then the sewage flows on to a series of V-shaped troughs, and

* A full account of these experiments, together with a drawing of the jet, will be found in Colonel Moore's 'Sanitary Engineering,' p. 629, 2nd edition, contributed by the speaker.

delivered thus drops down on to a bed of clinker. This to all intents and purposes is absolutely identical with Colonel Ducat's filter. Colonel Ducat tried that method in his filter, which was an adaptation of the Massachusetts filter. Colonel Ducat had a bed of filtering material 10 feet deep, and he tried a number of methods of distributing the sewage on to the bed by perforated pipes, by V-shaped troughs, by filling troughs and so on, and wherein this method constitutes a difference from that particular method of Colonel Ducat I should like to have explained. It appears to me that this is Colonel Ducat's filter over again, and if so there is no doubt it has certain specific advantages.. When we come to mechanical methods of distributing the sewage over the bed, there are the Caink distributor, the Whittaker distributor and others more or less good. The results which have been obtained by Mr. Stoddart's method seem to have been very good. We have had results which come well within the recognised standard of purification, but it does not follow that there is anything remarkable in that. I think I have heard of somewhat similar results from applying the bacterial process at Barking, Exeter and other places, and the nitrogen as a mark of purification does not appear remarkably high, but still it is satisfactory. Certain special experiments have been made with a view to obtaining the maximum degree of nitrification. I was present at the meeting of the British Association when Mr. Scott Moncrieff mentioned twelve grains of nitrates per gallon. I have myself obtained a degree of nitrification in certain experimental works of no less than fifty grains of nitrates per gallon. That shows that under experimental conditions we can do anything. In the laboratory chemists have few limits; but engineers have not always unlimited capital and chemists do not always have to work under laboratory conditions, and therefore working under practical conditions I am prepared to accept that this filter does give excellent results. The quantity of liquid purified per yard seems to be high, very high, and I should like to hear the results when dealing with two or three million gallons per day, because if those results could be kept up very excellent and valuable results have been obtained. I, as one who has had the bacterial treatment of sewage so much at heart, should have been delighted to hear that, for I have never cared by whom improvements have been made, so long as

the public receive the benefit of the work which is carried out all over the country as a corollary of the work carried out by the Massachusetts Board and by myself for the London County Council at Barking. I think it is a matter of congratulation that the principles enunciated during the last fifteen years have steadily won their way, and we have on all hands, whether by modification of this process, or of that or of the other, attained to a point when the old ideas of purifying sewage have been revolutionised by a better comprehension of what is known as irrigation. The result has been better work at a considerably reduced cost. I think this Association will welcome these experiments, and every point raised here and elsewhere will be thoroughly probed to the bottom, so that we may know the truth, the whole truth and nothing but the truth in regard to this difficult matter.

Mr. T. H. YABBICOM in reply, said: I am not here as an advocate of this or any particular system of sewage purification whatever. I thought these notes on the Stoddart filter might interest you, and I am glad they have produced a good discussion. The central idea of this filter is aëration, to try to get as much air as possible into the filter. That I believe is the whole secret of the thing. Mr. Stoddart has taken out a patent for this filter, and you cannot expect me to give him away by saying whether it is or is not precisely the same as any other filter. Some gentleman asked as to the cost, but as these works have been in a great degree experimental I could not give you the information. They have been conducted as works of experiment without reference to cost. It has been asked whether the tank into which the sewage is received acts as a septic tank: of course it does. The amount of deposit is very small. The higher rates of flow mentioned represent only the abnormal rates for a particular day and for a few minutes only. The samples were all taken on the dry weather flow.

RIFLE RANGES AND THEIR PUBLIC PROVISION.

By J. W. BRADLEY, City Engineer of Westminster.

In laying these particulars before the Members of this Association the Author does not advocate the provision of rifle ranges by local authorities in any spirit of opposition to volunteer ranges, or with the idea of relieving the War Office of their responsibility, but with the view that public ranges will afford scores of thousands of men who cannot give the necessary time for volunteering an opportunity to become efficient in the use of what is now the national weapon, and also in the belief that public ranges would give valuable training to the youth of the nation, who may afterwards do good service in one branch or other of our national defensive forces.

Any prejudice which may exist in the official mind against rifle clubs and public ranges would doubtless soon disappear when once they were established, and it may further be pointed out that other nations, even those approving of conscription, have established them.

Belgium, France and Switzerland in particular have had public ranges provided by local authorities and associations with the best results.

Probably most of the Members of the Association who visited the Paris Exhibition noticed the interesting exhibits in the Palais de Congrès of several of the French rifle clubs. Most of these clubs, if not all, have private ranges, are recognised and assisted in various ways by the municipalities, and the utmost enthusiasm and friendly rivalry prevails between the clubs of the different towns as may be imagined from the following particulars, taken from the Author's note-book, relating to three clubs which are selected from many as typical examples:—

The Société de Tir Alsacienne Lorraine de Paris has

supplied weapons and ammunition free or at reduced price to an average of 280 persons annually during the past seventeen years. It has held in the same period 20 contests yearly at 200 metres range, and last year supplied over 100,000 rounds of service ammunition for use on the club ranges.

The Société de Tir de Lyon has 866 members, and fired on the club ranges 20,892 cartridges during the past twelve months.

The Société de Tir de Nancy has 12 ranges of 100 and 200 metres and 3 revolver ranges, and in 1899, with 637 society members and 117 firing school members, used 66,445 rounds of ammunition.

These three clubs may be taken as types of the French town clubs, some of which did good service in the late Franco-German war, but most of which were called into being, or had their scope enlarged, by the war in question.

Lord Roberts has shown in India what can be done by encouraging this branch of military knowledge, for through his exertions the shooting standard of the native troops was considerably raised, and as compared with home regiments is as 55 to 33.

At the present time, in England, some facilities exist for rifle practice apart from volunteering proper or civilian rifle clubs, which, if properly developed, might not only be valuable as an additional means of spreading a knowledge of the use of the rifle, but would also be useful as a connecting link between civilian clubs and volunteer corps. The Author refers to the custom which obtains in some volunteer corps of permitting the entrance of civilians for rifle practice by enrolling them as honorary members on payment of a stated subscription. Apart from the national benefits accruing from the more extended knowledge of rifle shooting, the volunteer corps more immediately concerned obtains from the subscriptions of honorary members funds which can be used in divers ways for the benefit of the corps and its ordinary members. Failing a public range, these facilities for practice should be made the most of, but as they are not in themselves sufficient to create that popular interest in rifle shooting which so many hope to see, or to satisfy that interest when once aroused, other means must be found.

International competitions of late years have not presented

the British rifleman in any specially favourable light. Up till quite recently rifle shooting appeared to be on the down grade, for the standard of marksmanship both in the army and outside it had declined, and even the requirements of the Hythe School of Musketry were not of a very exacting nature.

It is not a matter for national pride that Bisley Camp is visited by only some 3000 riflemen out of a nation having a population of thirty millions; this is doubtless owing in large part to the general notion that the annual meetings of the National Rifle Association are intended for volunteers and regulars only; but as the National Rifle Association take little or no trouble to disabuse the popular mind, the competitions, open to all comers, are to a large extent monopolised by service men. For one thing, the National Rifle Association creates no local enthusiasm; this can only be done by each town, village or district having its own organisation, in touch, if you like, and perhaps, preferably so, with the National Rifle Association, who are perhaps somewhat apt to forget that "Mony a mickle makes a muckle," and to neglect those mickle, which with local fostering would help to swell the National Rifle Association into a far more powerful instrument of national defence than it at present is.

The Military Lands Act of 1892, with which is incorporated the Ranges Act of 1891, provides that a volunteer corps may with the consent of the Secretary of State, purchase land for military purposes, or the council of a borough or county may, at the request of one or more volunteer corps, purchase and hold lands on behalf of such corps, the machinery for the purchase of the land being provided by the Lands Clauses Act, with certain slight exceptions and additions. Some of the provisions being that the sanction of Parliament has to be obtained, one month's notice of intention to so apply has to be given to owners, lessees and occupiers, and a petition to be sent to the Secretary of State, who may thereupon call for such evidence as he thinks fit, and may dismiss the application or direct a local inquiry to be held as he believes necessary.

This being done, and the Secretary of State satisfied, he can then incorporate the application into a public bill; but if whilst the bill is pending in either House, a petition in opposition is presented, then the bill may be referred to a select committee and procedure follow as in the case of private bills.

Any loan raised under this Act is to be repaid in 50 years, the interest being at the rate of 3½ per cent.

A War Office return dated to April 1900, shows that in only five instances since the passing of the Act had use been made of its provisions; three ranges being thus acquired by volunteer corps in Lancashire, one in Yorkshire, and one in Cumberland. This would prove that the method of procedure to be followed was not popular and that a more simple method should be available.

Under municipal direction and influence, and through the enthusiasm local feeling would engender, ranges might easily be provided, managed and maintained with little difficulty and at slight expense.

A short Act of some half-dozen clauses, placing rifle ranges amongst the list of works for which local authorities may borrow money under the Public Health Act, and providing for their maintenance, would be all sufficient. There need be no compulsion upon any town to make such provision, for although many men would not be sorry to have it made compulsory, the larger the town, and the greater the necessity for a range the more easily would it be obtained. Should any local authority be lacking in initiative, all that would be needed, would be for the volunteers and the general public more directly interested in such matters to intimate to the representatives for their respective wards the great necessity for the provision of a range, and that one would be quickly found cannot be doubted.

Such a provision would be a very small addition to the multifarious duties and works carried out by the progressive communities of the present day.

In Switzerland, every village has its range, and by general law the parish has to supply and maintain it in an efficient condition; a parish committee also regulates practices, competition matches and the military courses of shooting.

In English boroughs the Watch Committee, which generally has charge of the policing of the town, would doubtless easily regulate the range, and provide custodians, more especially so as many chief constables are ex-military men, with an exact knowledge of the requirements of the case, and moreover, have a large proportion of discharged soldiers and reserve men under them who would be eligible as instructors and range-keepers.

Briefly stated, in the case of boroughs the *modus operandi* would be as follows. Upon representations having been made to the Watch Committee, the chief constable and the Borough Engineer would report as to a suitable site, together with estimates of the cost of construction; the committee would consider the same, and approving thereof, would forward to the Town Council a resolution asking for the necessary application to be made to the Local Government Board for the desired borrowing powers, and forwarding plans and estimates. The Local Government Board would direct a local inquiry to be held at which any interested parties could appear. The Local Government Board's Inspector, accompanied by an Inspector from the War Office, would view the proposed site, and hold an inquiry, ultimately giving their decision upon the merits of the case, and specifying a term of years during which the repayment of the money borrowed could be made; such term should be as long as possible, because land in the proximity of towns rarely decreases in value, and further, the benefits to be derived from the range will be reaped more in the future than the immediate present, thus differing materially from many municipal works. Sixty years would probably be regarded as a fair term, and upon this basis, and the money borrowed at 3 per cent., the annual charge in respect of interest and sinking fund instalment upon a range costing, say 3000*l.*, would only amount to 108*l.* per annum, which to an average town of 40,000 inhabitants, would mean a rate of only one-sixth of a penny in the pound.

As many towns have a penny rate which is almost entirely spent in providing free novel reading, a rate of one-sixth of a penny cannot be regarded as a bar to the provision of important and much needed works for increasing the value of the defensive forces of the country.

As regards the necessary instructor and range-keeper, he might well be an existing member of the police force, told off from town duties, thus relieving the town from an increased expenditure for such purposes, and without any appreciable diminution of police efficiency, for the rule that one police constable should be provided for every thousand inhabitants is still in force, although statistics show that crime has been and is decreasing from year to year.

In the cases of Urban and Rural District Councils, applica-

tion might in the first instance be made by them to the county authorities, who would then proceed in a manner similar to that just outlined for boroughs.

Inspection on the part of the Government of ranges thus provided might be carried out by the present Government Inspectors of Police, and a contribution from the Imperial funds made contingent upon a favourable report being given as to the up-keep, satisfactory control, and use by the citizens. A stand of arms might be provided by the Government free of charge, and ammunition at nominal rates to the local authority, which could be supplied to users of the range free, say on Saturday afternoons, half-holidays and bank holidays, and at cost price on other occasions. A scheme such as is outlined above would, it is believed, prove perfectly feasible, and would be a simple means of popularising the use of the rifle, and in training the ordinary citizen ready for any emergency that may arise in our national life.

It will probably be pointed out that the great difficulty exists in obtaining the requisite area of land for a range; but if in any locality the natural configuration of the ground is such as to make it exceedingly difficult to form a safe open range, then a closed range of 200 to 300 yards might be constructed; not forgetting that short ranges mean a longer tract of country at the back of the butt to be traversed by the bullets, if unprotected.

Shooting at short ranges of from 200 to 250 yards, used to be a thoroughly popular amusement, and the vital principles of rifle shooting must be observed as strictly, to ensure successful results on a short range as on a long one. At a short range a man can learn the aim corrections, manage his breathing, acquire a steady hand, and get accustomed to the mechanism of his weapon equally as well as he could on a longer range.

Many of the Swiss ranges are only 300 metres in length, it being assumed that any man shooting straight at this distance, and knowing his weapon thoroughly, will make satisfactory practice at longer ranges if occasion offers.

A modern rifle is essentially a weapon of precision, and its use must be learned as thoroughly as possible.

Short safety ranges, on the principles to be hereafter described, can be formed almost anywhere. Their construction, while much more costly proportionately than the usual open

range, is not so costly as to be without the means of any local authority, and the smaller district councils will find it assisting towards the retention of their population by affording a pastime which would be a relief from that monotony characteristic of village life which so many of the younger people seek to escape by migrating to the nearest large town.

Experience has shown that village rifle clubs, properly managed, provide an enjoyable diversion, particularly in districts where amusements are scarce, while they are exceedingly useful as teachers of the rudiments of the art of shooting.

One of the causes of the decline of rifle shooting, an important branch of national education, has undoubtedly been the closing of so many of the ranges on the plea of public safety since the introduction of the Lee-Metford rifle some ten years ago. A Parliamentary return, presented in February 1900, states that in the Eastern Military District alone no less than 31 ranges had been so closed. Probably nearly 300 ranges have been abandoned during the same period in the eleven military districts other than Aldershot and Woolwich. It has been said that rifle shooting could not be revived except under compulsion, and that as in earlier times archery had to be practised on Sundays and holidays by law, so rifle practice should be similarly insisted upon. But those who know how interesting rifle shooting is do not hesitate to say that, granted the necessary facilities for its enjoyment, it would quickly take hold as a popular sport.

The provision of even short ranges in towns and villages would not only afford interesting recreation, but would also be a long step in the right direction as affording a foundation for military efficiency.

Men may be made first-rate shots on a 300-yards range. With good eyesight, a first-class shot at 200 yards range is soon a good shot at 1200 yards, a few score shots at longer ranges making a short range trained man equal to almost any occasion. If men of military age in the principal towns were as well educated in the contrivances and aids to good shooting, and a knowledge of how and why, as they are in everything appertaining to any popular game, the nation would have a body of men who with some little military training would be of the utmost value.

A delicate instrument such as a modern rifle cannot have its uses assimilated all at once, and under present conditions, should any national emergency arise calling for a levy on the manhood of the nation, much time of the utmost value would be lost in imparting an elementary knowledge of its use.

A man with a knowledge of the weapon, altogether apart from the experience of its use, would be at a much greater advantage, and sooner proficient in its use, than another one who, with equal nerves and eyesight, was unaccustomed to the feel of the weapon.

Conscription may be regarded by many as a hardship, and a most undesirable contingency, but whatever opinion may be held with respect to this, many people—and the Author amongst them—think that every able-bodied male, on attaining the age of manhood, should be required, under some penalty or disqualification, to show that he had attained some standard, even if only a low one, of proficiency in rifle shooting. Most youths and young men of all classes, from the "hooligan" upwards, would only be too pleased to have an opportunity if granted the necessary facilities, and would form better men if they had some definite and compulsory manner of spending "out of doors" the time which so many at present find to hang heavily, and waste so recklessly.

Every person attaining the desired standard might be granted a certificate, or some small monetary reward, though from the Author's experience, the latter would not be necessary in view of the credit accruing to success. It is most important, however, that riflemen should not be harassed with payment of more than a merely nominal tax.

A suggestion was recently made that the Commissioners of Inland Revenue should have powers to issue a shilling rifle licence to any man, volunteer or otherwise, who certified that his rifle was suitable for service ammunition, that it would only be used on approved ranges, and for home defence if called on. Now by this means rifle shooting would receive some encouragement, and the Government would become possessed of a register of riflemen which in times of emergency might be exceedingly useful.

Like archery butts in the old times, ranges might also be open on Sunday afternoons, say from one o'clock to five or six

o'clock, and many men would find this a more enjoyable occupation than that of lounging about a public house.

Mr. T. C. Horsfall, who has taken a great interest in this subject, writes in the *Spectator*, March 10, 1900:—"The opening of rifle ranges, drill grounds and gymnasia, placed as close as possible to our towns and villages, would be the first attempt to enable the male part of the people to spend Sunday afternoons in a way conducive to health and general rightness of life, and at the same time attractive to the average boy and young man. The ordinary boy, who is not too ready to recognise a duty when it meets him, and not too eager to do what he knows to be his duty, would be much more willing than he is now to admit that it is his duty, and a duty not to be shirked, not to become a loafer and a frequenter of public houses on Sundays. If that duty could be fulfilled by the doing of things which, while not wrong, were pleasant, the providing of facilities for drilling and shooting on Sundays would have much more power to foster a sense of duty in boys and young men than the providing of facilities for playing such games as cricket and football, because the games, although far better occupations for Sundays than drinking or gambling are, are not felt by those who take part in them to be ways of fulfilling a duty towards their country. It is to be hoped that from the first, care will be taken to prevent licensing magistrates from granting licenses for the sale of drink to houses near rifle ranges and drill grounds."

At the numerous rifle meetings held in Switzerland, there is a marked absence of drunkenness and rowdyism, and weekdays and Sundays they afford opportunities of social intercourse for all classes.

As showing the great interest taken in this matter by Swiss towns, it may be mentioned that Zurich spent 30,000*l.* for a 400 yards range, with 96 6-foot targets and 288 figure targets, in addition to 32,000*l.* on a second range.

Out of 16,000,000 rifle cartridges used annually in Switzerland, more than two-thirds are for civil shooting.

This love of rifle shooting the Swiss take with them whereever they go, and even in far distant Singapore the Swiss rifle club is a recognised institution.

Major the Hon. T. F. Fremantle and Captain Grant have recently presented, by order of the Government, a report on

Swiss rifle ranges. This deals very fully with three classes of ranges, i.e. military target ranges, field firing ranges, and club ranges.

Some of these latter are exceedingly well furnished, and complete in all details. Reference may here be made to the Zurich Shooting Club. The shooting house is a two-storey building, and stands in a position giving a lovely view of the lake and town. On the lower floor are firing points for 53 targets at 300 metres, and 12 revolver targets, and on the upper floor firing points for 15 targets at 400 metres range.

The targets are set against the mountain side, a long wooden screen intercepting the view of one set of targets from the firing point of the other set. The targets and firing point are connected by a bullet-proof covered way, partly tunnel and partly constructed with concrete, and are in electric communication. A bell at the target is rung by the register keeper whenever a shot is fired, to warn the marker, this being an ordinary feature of the better class Swiss range.

Adjoining the club-house is a range for the use of the military, having target frames and targets for ranges up to 500 metres. There is also a field firing range and disappearing targets, a large sum having been spent by public bodies and individuals to provide sufficient accommodation of every kind.

As indicating the popularity of this range it may be mentioned that the refreshment pavilion has a large dining-room and a half enclosed dining-room, capable of seating nearly 3000 people. The wine cellars are large and well stocked, and the profits upon the refreshments sold figure largely on the club balance sheet.

A great feature of Swiss clubs is their economical management. Each club must have a minimum of 10 members, or it is not licensed, and a Government grant of 1·80 francs is earned by those clubs fulfilling certain governmental conditions. An income of a varying amount is also obtained by grass crops grown, sales of collected lead and of ammunition, cartridge cases returned for refilling,e tc. An average annual payment of two francs per member covers all charges for markers, accident insurance, etc.

Our system of balanced canvas targets was introduced into this country from Switzerland, where for many years it has been common.

Each district, according to its means, provides the requisite accommodation; the smallest villages dispensing with all fixed plant in some cases, the targets being then of canvas roughly fastened on a rough frame stuck temporarily in the ground during shooting, being erected at the required range at right angles to a public road, which forms a firing point. There is no shelter pit, but the marker, waiting behind any convenient boulder or knoll, inspects the targets after each series of shots. Any damage done to timber, etc., which may be in the background, by stray bullets is made good by the local authority (the commune).

These communes must by law provide rifle ranges, and they can take over land compulsorily on a valuation made by a duly appointed commission. They can also provide range buildings and give prizes, either in money or kind, and are liable for damage to private property through firing or the use of the range.

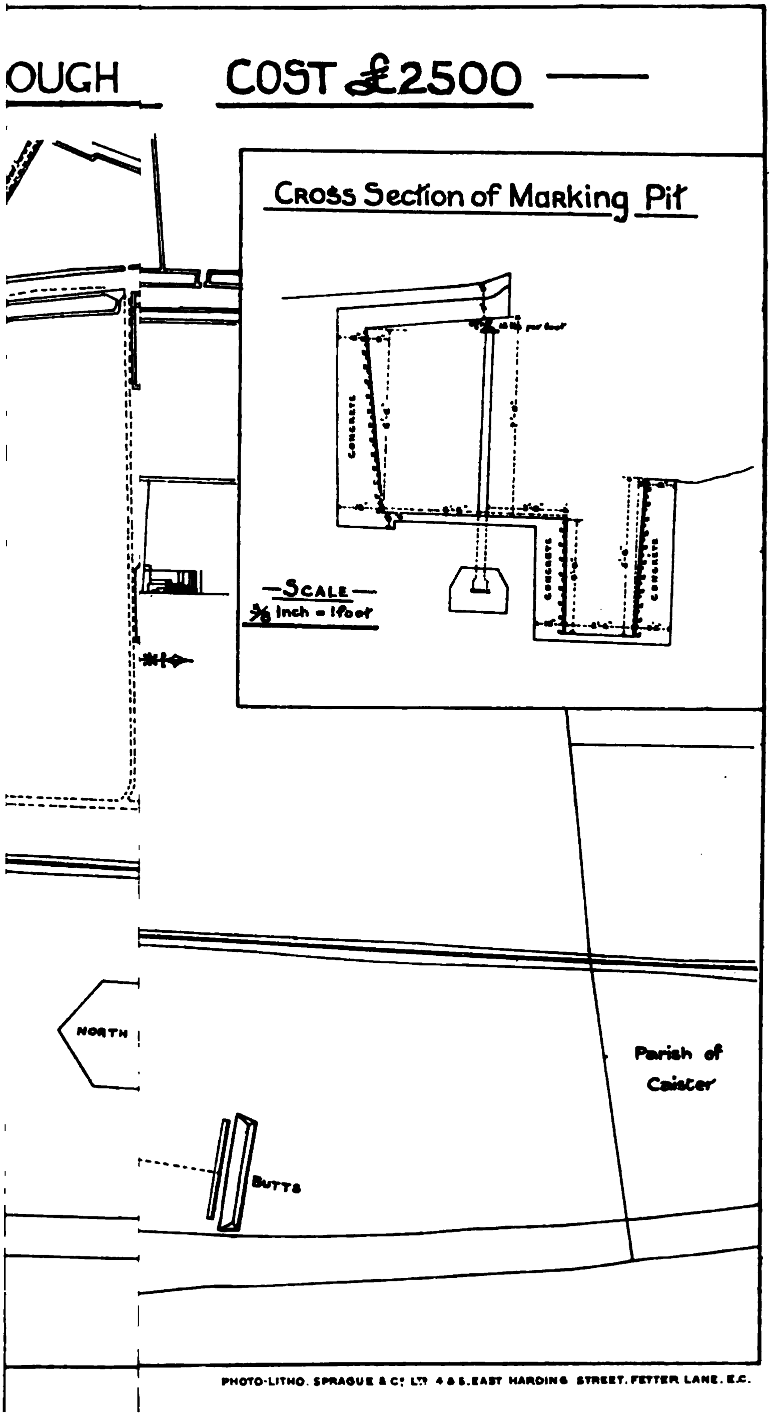
Switzerland has 3185 communes, 3447 rifle clubs, and 2735 ranges; 118 ranges being up to 300 metres only, 1683 ranges being up to 400 metres, 500 to 500 metres, and 434 to 600 metres, or above.

It will therefore be seen that the bulk of the shooting is at 400 metres, and whilst in England many ranges have been closed on the pretext of being dangerous, often on the slightest possible grounds, in Switzerland rifle practice is recognised as being a necessity of national life, and instead of finding excuses for closing of ranges, local action has favoured the retention of many, in fact some twenty-one per cent. of the entire total, which did not exactly come up to the official requirements.

It is true that in Switzerland the rugged nature of the country makes it much easier to find sites for open ranges than in other countries, but screened ranges can be constructed in the flattest and most open country in such a manner as to obviate all chance of danger to the public.

At Lucerne is an example of a range having in the direct line of fire and within half a mile of the butt, several houses; timber screens packed with shingle, at once the cheapest and most effective material, giving a sufficiency of safety.

At Milan, on flat ground, is a screened range having houses within a few hundred yards of the butt, this latter being a wall of about 30 feet high, with side walls, and high wooden screens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rising above them at intervals diagonally. This range has three timber screens to intercept high shots, and ricochet banks topped with loose sand every hundred yards.

As a more or less satisfactory alternative to screened ranges, or in conjunction with them, covered firing points may be used, the Morris safety shooting shed, invented for use in connection with Morris tube firing nearly twenty years ago, having been found useful in this connection. The shed was of simple construction, consisting of 1-inch deal boards backed with iron plates, the shed itself having front, roof and two side wings only; between the upright front and the target was a second vertical screen, placed some feet away from the shed front, both screens being loopholed in the line of fire, the loopholes being sufficiently large to allow a clear view of the target, and placed at a proper height to permit of the prone, kneeling, or standing positions being used. A shot passing through both loopholes could not fail to find the target; ill-directed shots passing through the first loophole would be stopped by the second screen.

The Committee of the National Rifle Association report on this, in 1884, stated that the absolute safety was secured at the firing point, and as the zone of fire is limited to a vertical area of the same size or a little more than the actual target, the safety shooting shed might be used with the utmost confidence in barrack yards or other enclosed places.

There are certain objections, both to the use of covered screens and firing points. The conditions of light, wind and weather are not the same as in the open, but firing sheds have some counterbalancing advantages, inasmuch as, whatever the condition of the weather, practice can be had, whilst the armoury, offices, etc., can well be placed under the same roof.

The Morris safety range, another contrivance by which rifle practice can be carried on in densely populated neighbourhoods with immunity from danger, is also worthy of description. Plan No. 1 shows the character of construction for a 300 yards range, although the dimensions there given are not arbitrary. This range is described in the pamphlet of the Morris Tube and Ammunition Company as follows:—

"At the firing point is a sloping platform marked out to suit height of any man, so that whatever his stature he can always take on the platform such a position that he can get a full view of the bull's-eye, and shoot at that from the proper

level. He should, when aiming, just see the bottom of the target and a white horizontal line, painted on the butt, 8 feet above the target. Immediately in front of the platform is placed a screen (A) composed, on either side, of boards and filled up with shingle. The object of this screen is to at once stop any bullets fired accidentally, or through carelessness, ridiculously wide of the mark.

"A little further towards the target is placed a similar screen (B) with a turf bank in front of it. The bank receives the bullets which are fired very low by nervous recruits, while the screen receives the wide shots which escape screen (A). Behind screen (B), and from the sides of the embrasure therein, slope long steel plates placed at a slight angle, and these deflect all high and wide bullets entering the embrasure, into the turf bank placed in front of ricochet chamber (C).

"The ricochet chamber has in front a single screen several yards in width. At the base of the embrasure in this screen is placed a steel plate under the proper trajectory of the bullet, and similar to that in screen B, and on the exact level with it. Bullets striking this plate are deflected on to the angle plates placed transversely, at intervals, in the roof of the ricochet chamber, and thence drop to the ground, broken into a great number of pieces. Steel plates are also placed on either side of the embrasure in screen C, just inside the ricochet chamber, in such a manner that all bullets striking them are deflected to the roof in an inward direction.

"The screens D and F, which are placed further towards the target, serve to confine high and wide bullets which have just cleared the ricochet chamber, by being deflected in a very slight degree, either from or before reaching it. This occurs by the bullets just tipping the edges of the angle plates.

"All bullets fired from the proper position above described, and passing clear of screen F, are certain to go to the butt, and cannot strike the ground in the intervening distance. Having seen these screens subjected to the most exhaustive trials that ingenuity could devise, we have repeatedly advocated their adoption as almost infallible provisions against accidents that would otherwise be frequent. Were these screens in general use, public confidence would so revive that many ranges now closed might be reopened, and even the imaginary risks of using them in such spaces as the town ditch might speedily

disappear, for, so far as human ingenuity can make them, these screens are absolutely safe."

The dangers of rifle shooting consist to a certain extent of the liability to lateral deviation of bullets, but to an infinitely greater degree to the incessant risk of projectiles passing over the butt or ricocheting from the ground. Although the Morris safety screens provide against both these sources of danger by confining the projectile within safe limits, the embrasures are so arranged that the marksman can see about 20 feet of the butt on either side of the target and 9 feet above.

One of the most recently constructed of safety ranges is at Wormwood Scrubs, and is shown on Drawing No. 2. This range is constructed on the safety shooting system, for individual firing at 200 yards, and butts arranged for 30 targets. The safety system is established by means of three screens erected close to the firing point, and the apertures in them are such that any shot leaving the last screen clear is confined to an area of about 6 feet round each target. Between each screen a turf bank is formed, which stops all low shots and ricochets.

The target station for the markers is slightly underground. The targets are placed 10 feet apart from centre to centre, and erected against a bank which slopes up to the wall of the convict prison, which is 37 feet high, covered with ½-inch steel plates. The firing station is made in three different heights, laid with ashes, and is such that the short man may have the same advantage as the tall man when firing in the higher position, the kneeling position being made in the same way in two heights, all staked out for the different targets. The bank for the prone position is at the back of all, made of turf, and has wooden steps leading up from behind, 4 feet high. The first screen, 17 feet high, is placed about 6 feet away from the standing firing position, and is built mainly of 9-inch by 6-inch timbers, 1-inch boarding, 8 inches of shingle ballast, and ½-inch steel plates at the back, resting on 18-inch brick piers. The aperture for firing through is 4 ft. 6 in. wide, and 5 ft. 6 in. high, open to the ground, and behind this screen, at a distance of 12 feet, a turf bank is erected, 4 ft. 6 in. high and 6 feet thick.

The second screen, which is erected 25 feet from the other, is constructed of the materials in exactly the same way as the first, but instead of having open apertures, it has two deflecting plates, shaped as shown at A on the lithograph attached, set up

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5 feet from the ground in the middle, and these two plates confine the shot to an area of 6 inches in height; while a third plate, attached to the structure behind, stops shots going too high, deflecting them to the turf bank erected 16 ft. 6 in. away 4 ft. 6 in. high, and 6 feet thick.

Beyond this is the third screen, made only of the timbers lined with the boarding and the steel plates, with an aperture 4 ft. 6 in. wide by 5 ft. 6 in. high, open to the ground; and 56 feet from this is erected another bank, 6 feet high and 10 feet thick at the base. From this, at a distance of 160 yards, are the targets, but there is a small sloping bank leading up to them, 4 ft. 6 in. high, the top of which is just below the bottom edge of the target.

The targets are arranged on the Jeffrey's patent signalling system, evenly balanced with the signalling board, and are 4 feet square, having a 12-inch bull and a 24-inch ring. They are constructed on light wooden frames, with two layers of Jeffrey's patent paper stretched tight across.

The signalling pit is neatly and substantially built in brick and cement, with recesses and racks for the targets. It has an asphalt floor, with a roof of galvanised iron. There is seating accommodation for the markers, and telephone communication to the firing stations. Beyond the targets is a small retaining wall, 3 ft. 6 in. high, and a bank from this slopes up for a distance of 32 feet to the wall before mentioned covered with the plates, which serves for a base for all shots. The range has been constructed for a little over six years, and no accident has occurred in its locality. The total cost for its erection was somewhat over 5000*l.*

Those interested in this subject, when visiting the Glasgow Exhibition, should make a point of seeing the electric self-indicating targets for use in connection with short ranges which are there exhibited.

In concluding this paper, the Author wishes to point out that the provision of rifle ranges by public authorities is no entirely new thing, Boston, Conway, Doncaster, Norwich, Nottingham, Great Yarmouth and other towns, having constructed them, that at Nottingham having cost 19,000*l.* By the courtesy of Mr. Cockrill, particulars of the long range at Great Yarmouth are shown on Plan No. 3 attached.

In May 1900, Lord Salisbury spoke with such evident con-

viction as to the value of rifle clubs that it seemed possible that the Government would take some great step to help forward their initiation and maintenance, and to supply the necessary ranges. These steps have yet to be taken, and in the opinion of the writer no better way of taking them could be devised than by placing the matter in the hands of local authorities.

In acceding to the request of our esteemed President to prepare this paper, the Author hopes that it may lead many of the Members of the Association to take a personal interest in the matter, and to use their influence, as far as they possibly can, to press forward the provision of these aids to national defence.

DISCUSSION.

Mr. E. P. Hooley: I shall have pleasure in proposing a vote of thanks to Mr. Bradley for bringing this matter before us, though personally I do not think I can thank him for raising such a question here. I think the preliminary part of this paper might well have been brought before the House of Commons, and not before an association like ours, because it is very debatable whether he is on the right track. As a volunteer officer I think he would get his knuckles rapped for suggesting some of the things set forth in the paper. I would suggest to anyone who thinks of building a range that he should go and see those which are recommended here as examples, and then he will doubtless change his opinion as to the right way of building a range. I would strongly advise anyone who is going in for range building not to follow the procedure which Mr. Bradley advises in this paper. You cannot build a range anywhere to do any real good, unless you get the authority and approval of the War Office. The first step to be taken is to get that approval, and not first to build your range and to go to the War Office afterwards, because in nine cases out of ten the money would be wasted as the authorities would not pass the range. Take some of the ranges recommended here. The Yarmouth range looks very pretty on paper, but I had a few of the most uncomfortable hours of my life at that range. It is said here that range cost 2500*l.* If it cost that sum it is 2500*l.* absolutely wasted. You have the north battery at one end of the range and the fishing boats at the other end. I took 250 men there at four o'clock in the morning and we were still

waiting at eleven o'clock to have a shot, and it was raining all the time, for this range has the sea as a back, and you will understand when I say the fishing fleet was just outside the risk we ran during volley firing. The people at Caister asked for an injunction to stop all firing at the range because it was dangerous. Short ranges, such as suggested in the paper, are absolutely useless from any military point of view. Mr. Bradley says men may be made first-rate shots on a 300 yards range. "With good eyesight a first-class shot at 200 yards range is soon a good shot at 1200 yards." Mr. Bradley never made a greater mistake in his life. You will find that a man who can shoot at 200 yards will make the most fearful shots at 1200 yards, and would as likely as not kill the men he is trying to defend. Then Mr. Bradley suggests that upon representations having been made to the Watch Committee, the chief constable and the Borough Engineer would report as to a suitable site. I am surprised at Mr. Bradley suggesting anything so impossible. Then again I strongly object to the statement that British riflemen do not compare in any favourable light with foreign riflemen in shooting capacity. In shooting in International competitions, Englishmen have beaten the foreigners easily when on equal terms, but the foreign riflemen want to have the wind cut off and all manner of artificial aids, but the English representative men were shooting in the open, as Englishmen always would shoot. Mr. Bradley says up till quite recently rifle shooting appeared to be on the down grade, for the standard of marksmanship both in the army and outside it had declined. Well, as a matter of fact the standard of shooting has gone up from 75 to over 120 in a regiment I know something of. If that is not progress I do not know what is. Then he says further, "It is not a matter for national pride that Bisley Camp is visited by only some 3000 riflemen out of a nation having a population of thirty millions; this is owing to the general notion that the annual meetings of the National Rifle Association are intended for volunteers and regulars only, but as the National Rifle Association take little or no trouble to disabuse the popular mind, the competitions open to all comers are to a large extent monopolised by service men." If we were going to cater for all the thirty millions we should each want a range in our own back gardens. I do not think the question is one for our authorities to tackle, but is entirely a matter for the Government.

Mr. A. D. GREATOREX: I am not a volunteer officer now but was some years ago. We have a rifle range at West Bromwich which is in a large park, and this range has been closed on account of the danger to the inhabitants of the adjoining district. When I was at Southampton our rifle range was directly at the end of the Solent, and that range had to be closed on account of the danger of anyone rowing out in the river. We had a range of 1200 yards, and even under the best circumstances we had to have the range closed. Mr. Hooley has referred to the difficulty of having to wait hours to fire at the Yarmouth range. When I was in the Artillery I have known what it was to go down to the fort for gun practice and fire only two shots in a whole day. This is a subject which the Government should take up. I do not think any town should be called upon to provide rifle ranges out of the rates, though I agree that rifle ranges should be provided at places accessible to volunteers. The ranges should be provided in districts, so that the men would not have to travel very far to get rifle practice, because regular practice is required to bring our volunteer shooting up to a high standard. I am quite certain that the shooting of the British regular and volunteer stands higher now than ever before. It does not require discussion to prove that fact. In the past it has not been so much the want of ranges as the distance they were away from the volunteers and the time taken in getting to them. I quite agree with Mr. Hooley that ranges should be provided by the Government and not by the municipalities.

Mr. W. J. DIBDIN: In listening to this discussion which is neither engineering nor chemistry, my mind was carried back to an old branch of work in which I used to take great interest. Having had fifteen years in the ranks I can appreciate somewhat keenly this question of the need of rifle ranges. It seems to me that the observations on the question are entirely good, though I cannot think that Mr. Bradley's suggestion that county and borough councils should provide rifle ranges will solve the problem, and a very serious problem it is. For many years I took great interest in rifle shooting, and the solution of the question has always appeared to me to be this. In most districts there is one landed proprietor or magnate who has the means and the power to provide facilities for rifle shooting if he has the will to exercise those means. And it appears to me to

be a matter which can be better solved by the public spirit of individuals than by any official procedure on the part of either the ratepayers or of the Government, because immediately the Government or the local authorities require land you know the difficulties which have to be met and overcome. Whereas a landlord can arrange at once that the thing shall be done. If some of our landed proprietors would assist in this matter, and provide facilities for shooting, it would not be a great cost to them, as the land would not suffer in any way. In the large towns I admit that the difficulties will be great, but they must be overcome by the volunteers going out to the ranges in the district. I throw that out as a suggestion, because you may go on looking to your local authorities and find they can do nothing for you because of opposition, expense and delay.

The PRESIDENT: We have had this question of rifle ranges up for consideration at Leicester. The range which we are considering here is of the same type as the one at Wormwood Scrubs. I am assured by correspondence, brought to me by Colonel Sarson, that this type of rifle range is absolutely safe. We have the detailed drawings. The men have to fire through screens, so arranged that it is impossible for bullets to get away. They have buildings at the back of the range at Wormwood Scrubs, and experience there has shown there is no danger in it. Unless a man fires very recklessly at the side of the screens, or into the air, it seems impossible for the bullets to get away. The proposal is that the corporation should assist the volunteers by finding a site, and that the range should be built at their joint expense. We have tried to find a site, but so far have met with great difficulty. I cannot help thinking if, as appears to be the general opinion, these short rifle ranges would immensely facilitate the practice of shooting in our thickly populated towns and districts, that it would be a great advantage to the country if local authorities would do their best to help forward the provision of such ranges. It would be better than conscription; it would be better than having to maintain out of our pockets a greatly increased permanent army. I am in favour of it as far as it is practicable to carry it out.

THE LIABILITIES OF LOCAL AUTHORITIES UNDER 38 & 39 VICT. CAP. 55, SEC. 24.

BY F. W. MAGER, SURVEYOR TO THE RURAL DISTRICT COUNCIL OF WALSALL.

IN submitting a paper on the subject of house drainage, the Author is conscious of the fact that the published Proceedings of the Association already contain, in the forms of both paper and discussion, contributions of such great permanent value that further treatment of it, at his hands at any rate, might well be thought superfluous.

However, during the past two years, the phase of the subject indicated by the title of this paper has been very prominently before him in his own practice, and the hope that some account of the experience which he has gained may assist those Members of the Association who may be called upon to advise their councils under similar conditions, is his excuse for laying before you the following notes. He has decided to give an account of a chain of actual circumstances as they arose, in preference to dealing with the subject in a more general manner, as he trusts that that course will best bring out such points as may be suitable for discussion.

The Author has just reconstructed the drains of 1313 houses under the following circumstances.

Until recently a certain portion of his district was already sewered by means of numerous short sewers discharging at haphazard into ditches and watercourses, which produced a plentiful crop of nuisances and claims for poisoned cattle, the only crop, in fact, that the sewage did produce at that time. All the houses in this area, within reach of the sewers, drained into them; the remainder into cesspools or elsewhere. The growth of the area and increase in volume of sewage rendered it necessary to replace this with a comprehensive sewerage system. A scheme was prepared by Mr. J. E. Willcox, of Birmingham,

and carried out by the Author on his arrival in the district. The whole of the old sewers were retained for storm water, which was specially necessary, as five-twelfths of the volume of sewage had to be pumped to a height of 30 feet, and one-twelfth to a height of 14 feet.

All the houses within the sewered area, whether previously drained by the superseded system or by means of cesspools, were to be connected to the new system. When the main sewerage contract had reached a sufficiently advanced stage, the steps to be taken in this matter had to be considered by the Council.

Six-inch Y junctions, with stoppers jointed in clay, had been fixed in numbers sufficient both for existing buildings and for those likely to be erected hereafter. These junctions were indicated by plates, and a record was also made during the progress of the work.

It was decided to recognise combined drainage both on sanitary and economical grounds, and that disturbing element was therefore eliminated.

Thus the first set of factors which had to be taken into account was:—

(*a*) The condition generally of the existing house drains.
(*b*) The drainage regulations adopted on the Author's advice some twelve months before.
(*c*) The law relating to the drainage of houses.
(*d*) Cost of necessary work.

As to (*a*) the properties to be drained were broadly divisible into three classes, of which examples are given in drawing No. 1.

Class 1 included those known to drain direct to cesspools or ditches or without existing drains. 87 houses belonged to this class.

Class 2 included the properties known to have drains, discharging into those sewers which were now about to be superseded, these drains being untrapped, choked up, or otherwise defective, either wholly or in parts. Of these there were 64.

Class 3 included those premises possessing drains connected to the old sewers, satisfactory as drains, but laid in such a direction or to such levels as not to allow of connection without considerable modification. Some again admitted large quantities subsoil water from cellars and land springs. The remainder

simply required to be cut out of the old sewers and jointed up to the new. This class numbered 1162 houses.

(b) *Drainage Regulations.*—The clause specially pertaining to this matter was:—

"The communication with the sewer shall be made and the length of pipe, up to the curtilage of the premises to be connected, constructed by the Council; the person giving the notice required by the regulations undertaking to pay the costs incurred as certified by the district surveyor."

It was further required that the joints should be made with tarred cord and Portland cement mortar. This was because of the absence from the district of really suitable jointing clay and of the wetness of the subsoil. Also the provisions as to trapping and ventilation of the model bye-laws were incorporated with the drainage regulations.

(c) *The Statute Law Relating to House Drainage.*—By Section 23 of the Public Health Act, 1875, it is enacted that where a house is without a drain sufficient for effectual drainage, the local authority shall compel the owner to connect to any sewer within 100 feet, and that in default they may do the work themselves and recover the cost. It also provides for the apportionment of the cost of constructing new joint drains. Section 24 on the other hand enacts that where a house possesses a drain sufficient for effectual drainage and communicating with a sewer, but is not adapted to the general sewerage system or is otherwise objectionable, the local authority must do the work of adaptation or reconstruction at their own cost. In other words, the procedure for the classes of properties 1 and 2 was laid down in Section 23, and for class 3 in Section 24.

(d) *Cost.*—The Author estimated the cost of draining—

	£	s.	d.
Class I. at	291	0	0
Class II. at	214	0	0
Class III. at	3891	0	0
Total	£4396	0	0

It will be seen that two courses were thus open to the authority. 1st. To compel owners of property comprised in Classes 1 and 2 to do the necessary works themselves, and to borrow funds for Class 3 only; 2nd, to borrow funds for the whole and recover from Classes 1 and 2. The indebtedness of

the Council was, however, already somewhat heavy, and it was decided, before taking either course, to offer special facilities to property owners to get the work done well and economically at their own expense, rather than increase the rates of the district.

Arrangements were consequently made of a nature sufficiently indicated by the contents of a circular, of which the following is a copy.

WALSALL RURAL DISTRICT COUNCIL.

Clerk's Office,
29 Leicester Street, Walsall:
January 1899.

Dear Sir,

Sewerage of Pelsall and Rushall.

This Council have entered into a contract, which they believe to be a reasonable one, with Mr. John Mackay, of Smethwick, who has laid the new system of sewers for the parishes of Pelsall and Rushall, for the laying and connection of house drains therewith, and I am directed to ask you to permit them to lay and connect with the new sewer drains for the following houses, of which you are the owner.

Description of Premises. ______________________________

If you assent to this, the works will be executed by Mr. Mackay under the superintendence and control of the Engineer to the Council, and you will be charged by the Council on the basis of Mr. Mackay's tender, plus 5 per cent. for inspection, collection, &c. The schedule of prices may be inspected by you, and any further particulars obtained at the office of Mr. F. W. Mager, Surveyor to the Council.

I need not point out to you how desirable it is for the general health of the parish that the houses therein should, without loss of time, be connected with the sewer; and, too, that it is impossible for the Council to have the roads put into a satisfactory state of repair until this has been done.

If you agree to have the work done, will you please complete and forward to me the Memorandum on the fly-sheet hereof. This offer, is, of course, without prejudice to the powers with respect to the

matter that the Council have under the Public Health Acts, and to the regulations of the Council whereby all work outside the property owner's boundary is required to be done by the Council at the cost of the Owner.

Yours faithfully,
(Signed) A. H. LEWIS,
Clerk to the Council.

This circular was addressed to all owners of property without regard to liability.

The monetary interests of the individual property owner, and the monetary interests of the Council as representing the general body of ratepayers, were divided by too sharp a line for this plan to succeed.

Thereupon—on a report from the Author—his Council decided to carry out the whole of the work themselves, to serve notices, and recover costs where permissible, to dispense with a contractor and to authorise the engagement of a special staff, and the purchase of the necessary plant and materials.

A loan of 4300*l.* was obtained, the only condition attached to the same by the Local Government Board being the very obvious one that all sums recovered from owners should be applied to the reduction of the loan.

The departmental construction of the work was then commenced. It may be divided into:—

Materials and plant.
Labour and supervision.
Records and accounts.
Details of construction.

Quotations were obtained for the whole of the materials and plant, which were bought specially for the work. The principal items may be of interest and are therefore given below.

MATERIALS.

6 in. stoneware pipes.
4 in. stoneware pipes.
6 in. to 4 in. taper pipes.
6 in. to 4 in. junctions.
6 in. to 6 in. junctions.
4 in. to 4 in. junctions.
6 in. Doulton's (Fig. 31) intercepting traps.
6 in. and 4 in. bends of $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{1}{4}$ sweep.
8 in. by 8 in. outside at top yard gullies.

9 in. by 9 in. stable gullies (as Doulton's Fig. 37).
6 in. saddle junctions.
6 in. and 4 in. channel pipes, bends and junctions.
6 in. and 4 in. stoneware stoppers.
2 in. glazed stoneware sink bends and pipes.
3 in. brass cobweb gratings.
Cast-iron lamphole covers, weight about 40 lbs. each.
Cast-iron manhole covers, weight about 165 lbs. each.
4 in. cast-iron vent pipes, weight 18 lbs. per yard.
4 in. swan necks, bends and elbows for same.
Wrought-iron pipe stays, galvanised malleable step irons, &c., &c.
9 in. by 3 in. deals, 1 in. and 1½ in. elm poling boards, 4 in. round struts, hard wood pages, tarred caulking yarn.
The plant included—1 oil sheet, 3 travelling rods, 3 straight edges, 1 dumpy level and staff, 30 drain rods and connections, 3 caulking tools, 8 chisels, 1 sledge-hammer, 2 cross-cut saws, 2 axes, 3 mauls, 4 riddles, 11 trowels, 3 hurricane lamps, 1 oil can, 1 branding iron, 2 chains and hooks, 2 tape measures, 3 spirit levels, 50 pick-heads, 49 shovels, 12 grafting tools, 3 steel bars, 6 rammers, 2 tool chests, 2 springers, 1 hand cart, 12 stone hammers, 17½ lbs. rope, 1 concrete drum, 1 paving mallet, 5 navvy barrows, 14 in. galvanised pump, 1 iron skip, 2 jack rolls, 1 watch-box and 1 wooden office fitted up complete, on wheels.

As to this list all that need be said is that constant care was exercised to see that a sufficient stock of every item enumerated was maintained at all times, as in this kind of work the unexpected is sure to happen, and without this care irritating delays and monetary loss would have resulted.

Labour and Supervision.

Three gangs of men were formed, each gang was composed of one all-round working ganger, a couple of timber men, one or two good pipe-layers, with six or seven excavators and surface men; each gang was sufficient to keep three short jobs, adjoining each other, going at once, the excavators and timber men getting the cuttings open in one, the pipe layers working in the second, and the surface men filling in and cleaning up in the third. It does not do to get gangs mixed up, but nowhere else has a shirker more opportunities than on works of this kind, and in the interests of good supervision the gangs were kept, as much as could be, in adjoining streets.

Two bricklayers with their labourers and a watchman and boy completed the labour arrangements.

Records and Accounts.

In addition to the general supervision exercised by the Author, whose rule may be expressed in the paradox "regular irregularity," that is—6.10 a.m. visits one day and 5.25 p.m. the next—a resident engineer and junior assistant were employed constantly on the works.

They occupied a travelling office, and their duties were:—

1. To prepare plans of buildings showing existing drains. These plans were very quickly made by plotting direct, to a scale of 40 feet to the inch, into a field book ruled in sections of 5 feet square to that scale; names, of owners and occupiers, and all other particulars obtainable were noted alongside. On these plans were marked from day to day the new works as they progressed, and in this way the Author succeeded in getting a complete record of every house drain dealt with; and as these books are kept up to date for all new buildings, a drainage plan of every house connected to the sewers in the district will eventually be available at practically no cost whatever.

The drawings on Sheet No. 1 are examples of these plans.

2. To set out the new works, to inspect them and measure them up before filling in.

3. To keep an account of the time and materials expended on each job separately. This account was kept in a book of handy pocket size. Time and materials were entered on one side and measurements on the other, and thus it was possible to ascertain at a glance the profit earning capacity of each gang. This book was also a check on the store-keeper's accounts.

4. To keep time, "sub" and pay the men.

5. To send in all books at the end of each week for examination and for the necessary entries to be made into general wages and stores books, and for items to be posted to the "Sundry Debtors' Ledger" where legally recoverable.

Details of Construction.

A few practical points are all that it is proposed to instance.

The ground throughout was very treacherous, and laying drains in narrow entries, where the levels brought the work

below the adjacent foundations had to be proceeded with as follows.

Open cuttings were taken out in lengths of 14 feet at a time, the cuttings timbered with 9 in. by 3 in. walings, 4 in. by 4 in. struts, and either 1 in. poling boards in ordinary work, or 9 in. by 3 in. runners in running sand. The timbers were left in, and each short cutting filled by back throwing from the next length taken out to save the labour of barrowing the spoil out and back again. Not a single settlement took place anywhere on the works, although many of the buildings were old and much pulled about by mining operations.

Connections to deep sewers. Ruling gradients of 1 in 32 for 6-inch pipes, and 1 in 24 for 4-inch pipes were adopted. Where a considerable drop from any drain to the sewer was necessary this was formed as shown on drawing No. 2. In this construction it was necessary to have the ground up to the level of the upper bend consolidated in a specially thorough manner, as the slightest settlement would cause fracture of the drain at this point.

In setting out the work from the sewer to the interceptor, the trench was kept well on what may be called the upstream side of the sewer junction, so as to allow for the bend and also for the possibility of the junction indicator being a few inches out one way or the other. Had this not been done, bad alignment of pipes would have resulted, or a lot of money would have been wasted on unnecessary excavations.

In order to make a clean job of the actual sewer connection, the ground was always excavated right through the original main sewer cutting to the undisturbed ground on the opposite side, and runners were put down where the house drain intersected the sewer trench.

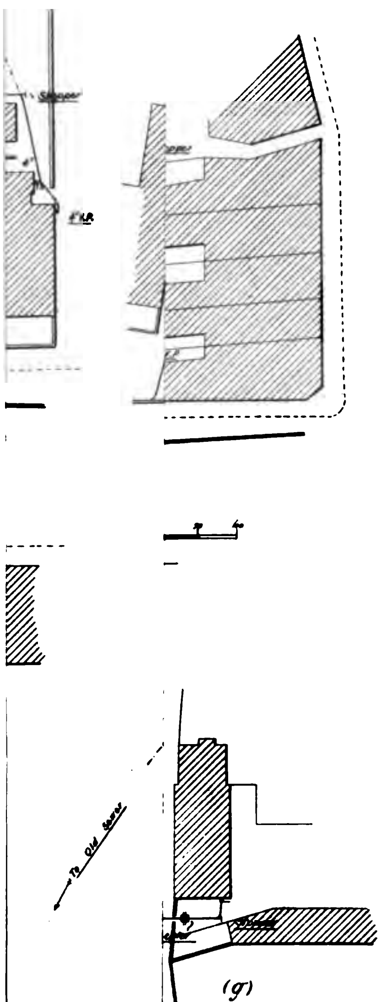
Ventilation.—Ordinary upcast shafts were used at the upper ends of drains, while for the fresh air intakes surface grids, as shown in detail; the sectional area of the slots in the grids was twice that of the upcast shafts.

In the neighbourhood dealt with, mica flaps would have been pure waste of money.

In some cases, one of which is shown in drawing No. 1, the drains were so short that the provision of two ventilating openings appeared absurd. One opening only was therefore adopted as being practically sufficient in such cases.

DRAINAG

No 1



Engineer & Surveyor

WALSALL RURAL DISTRICT COUNCIL

O. SPRAGUE & Co LTD 4 & 5, EAST HARDING STREET, FETTER LANE

All lamphole shafts were surrounded with concrete filled into a drum as they were brought up. This concrete block also formed the foundation for the setting of the ventilating covers. Had this not been done, the settlement of the ground would have caused distortion of the shafts, and an unsightly heeling over of the tops.

The following are some of the measurements of the work as executed.

7635 yds. 6 in. pipe of various depths.
3194 yds. 4 in. pipe " "
136 6 in. by 6 in. junctions.
664 6 in. by 4 in. "
269 4 in. by 4 in. "
94 6 in. by 4 in. tapes.
560 6 in. bends.
966 4 in. "
312 6 in. syphons and ventilating tops.
579 stoneware gullies.
78 cubic yards cement concrete.
1172 super yards paving relaid.

The total cost worked out at 3705*l*., thus showing a saving of 691*l*. on the estimate. The cost equalled an average expenditure of 2*l*. 16*s*. 5*d*. per house.

This included an expenditure of about 100*l*. on tools and plant, the present value of which should really be credited to the job to arrive at the correct prime cost. This formed the nucleus of a stock of plant which now includes everything likely to be required for the construction of ordinary engineering work by the Council.

The method actually adopted in apportioning cost as between the Council and private owners, may be broadly explained by reference to actual works carried out and illustrated on the block plans.

In example (*a*) the whole of the old drains were 4 inches diameter, draining into two cesspools; a few short lengths of pipe were sound, the remainder choked and broken; that is to say, not sufficient for "effectual drainage." The whole cost of the new works was charged to the owner under Sec. 23.

In the case of example (*b*) the drains were good and were connected to an old sewer retained for surface water only, the new sewer was laid alongside and the Local Authority were clearly liable for the connection under Sec. 24.

Example (*c*) was a little more complicated: the houses previously drained into a sewer, but a portion of the main drain was choked and so were some of the branches. The Author considered that the owner would have effectually answered the notice served on him by taking up and relaying these drains, and an amount equivalent to the cost of that work was charged to him, while the balance remained a charge on the Council.

Example (*d*) is a plan of old houses built in a very rambling manner. What remained of the old drains when the Author visited the place, would have discharged into a cesspool if that adjunct had not caved in a little while before. The new drains had to follow a rather devious course, and as this class of property would not bear the cost of inspection chambers, stoppered junctions were placed at all angles. The whole cost of this work was recovered from the owner.

The premises in example (*e*) were partially drained into a cesspool, the remainder going into a drain connected to an old sewer. This drain would have been incorporated with the new work, but that it unfortunately carried off a large land spring. It was found best to retain the old drain for the land spring and construct a new line of pipes for the sewage. The cesspool was done away, and the water-closet, which discharged into it, connected to the new line of pipes. An amount equal to the cost of connecting the water-closet to the superseded drain was charged to the owner.

Example (*f*) is a simple case under Sec. 23, but shows the use of stoppered junctions where the value of the property did not admit of inspection chambers. While (*g*) shows the method adopted for the ventilation of very short drains.

In conclusion the Author wishes to say, that the greater number of properties drained were of the artisan class rented at from 4*s.* to 6*s.* a week, and that consequently the strictest economy consistent with reasonable sanitary efficiency, had to be exercised in every detail.

DISCUSSION.

Mr. A. E. Collins: I desire to move a vote of thanks to the Author of this paper. I think Mr. Mager has been a little too liberal with the owners of property. He seems to me to have

gone out of his way to find a reason why the authority should do some of the work at its own cost. If I find a portion of the drainage of a premises requiring to be dealt with is bad I charge the whole of the works necessary to be done to the owner, and do not construct one part at the cost of the owner and the other at the cost of the authority.

The PRESIDENT: I think Mr. Mager deserves our thanks for this paper. I quite agree with Mr. Collins that he has been very liberal to the owners of property in his district.

The vote of thanks was accorded by acclamation.

ASYLUMS OR HOMES FOR THE INSANE.

BY J. VICKERS-EDWARDS,
COUNTY SURVEYOR, WEST RIDING, YORKS.

THE task of designing an Asylum or Home for the insane is by no means an easy one ; still at the same time it presents many objects of interest to those concerned in the erection of such buildings. The Author does not propose entering into any minute description or to make much comment upon the constructive works necessary in such buildings, save that the works necessitate the employment of an architect, and constructor of such buildings possessing the knowledge and skill of a Water Engineer, Sanitary Engineer, Heating and Ventilating Engineer, and Electrical Engineer. You will see, therefore, how varied the works are, and how onerous are the duties of such a gentleman.

The Commissioners in Lunacy (England) have issued a most excellent pamphlet in the form of "Suggestions to Architects" and others who have the erection of this class of buildings, and if due regard is paid to such "Suggestions" the architect, or those having the charge of the construction of such buildings, will not have much difficulty in arriving at a satisfactory solution of the problem ; at least that has been the experience of the Author, who has had for more than twenty years considerable transactions and conferences with this learned Government Department, viz. in the erection of Menston Asylum, in the West Riding of Yorkshire, upon which an expenditure of upwards of 400,000*l.* has been incurred, which provides accommodation for 1600 cases; also in connection with the West Riding Asylum at Wakefield and the Wadsley Asylum, near Sheffield; the building of a new hospital and cottage homes in connection with the Wakefield Asylum, at a

cost of over 120,000*l.*; the building of a retreat for private cases, which may cost, when completed, 300,000*l.*, known as Scalebor Park, situate at Burley-in-Wharfedale; and the large Asylum at Storthes Hall, near Huddersfield, with its 2000 patients, which will cost when complete above 600,000*l.* The Author therefore thinks, having had such vast buildings to design and carry out, that he can speak with authority on matters pertaining to Lunacy and the Lunacy Commissioners.

It is unnecessary to enter into detail as to the superficial and cubical areas of the various day rooms and dormitories, the percentage of single rooms and accommodation for the staff, as information of that description can be obtained from the valuable pamphlet mentioned. It might perhaps be pointed out that it ought to be the aim of the architect to produce surroundings as bright and cheerful as possible as he can, i.e. so far as his purse will allow. The Author refers to well broken up rooms, well lighted spacious broad corridors, a free use of glazed brickwork or warm coloured tiling, wax polished hard wood floors; tiled dadoes, wooden dadoes, glazed brick or tiles in all the sanitary spurs; also the furniture, which should be of good sound material, nice design, and pleasing to the eye, made so as to minimise the lodgment of dirt and dust. Before passing from constructive works, reference may be made to the following matters:—

Firstly, Drainage, which should always be constructed on the most modern and approved lines, with ample inspection chambers and manholes, and all internal sanitary fittings should be capable of instant and complete inspection. The Author has come to the conclusion that for asylum purposes all outside sewerage drainage should be constructed in cast-iron pipes with leaded joints, and this is being done in the West Riding.

With respect to sewage disposal works; as asylums are now rated to the local authorities, the Author would strongly advise that all asylum authorities should insist upon local authorities taking their sewage and dealing with it.

Secondly, as regards heating and ventilation works, the system known as the "Plenum" received very favourable reception a few years ago, and has been largely adopted in some of the asylums in this country. The Author has adopted

this system in two large asylums in the West Riding, still he regards it as a system which requires considerable care and watchfulness on the part of those who have the supervision thereof; and although at one time impressed with it he has latterly come to the conclusion that the system which gives the most satisfactory results, with a minimum amount of anxiety and supervision, is, heating upon the low-pressure principle with about 5 lbs. of steam, taking the same from the exhaust of your engines, and having a good open type of radiator fitted with the Webster atmospheric valves. But this is a subject so varied and presenting so many difficult features that the time at our disposal is too limited to enter into it in a paper of this character.

Thirdly, as regards the adoption of electric light in asylum buildings, there can be no two opinions as to the desirability of the introduction of this light both for the health of the patients and the cleanliness of the interior generally; it produces a very different state of things to gas as regards both the atmosphere of the wards and dormitories, whilst the cost of the upkeep of such dormitories and wards must certainly diminish by the use of electric light. In fact, the Author will go as far as to say that no new asylum should ever be built without a system of electric light being installed. He can speak from experience: at the old Wakefield Asylum, an institution commenced in the year 1818, built upon lines extremely faulty (according to present day views), such a scheme has been put down at a cost, including light and power, of 20,000*l.*, and the difference in the wards and the health of the patients has been most marked. Such sum, however, includes light and power for the New Acute Hospital Cottage Homes and Home for Idiot Children.

Thinking it may perhaps interest you, the Author proposes giving a short description of visits made by him to various asylums in this country, Scotland and Germany, with a view to seeing what were the best features in such institutions that might with advantage be introduced into our asylums; and also for the purposes of seeing what might beneficially be avoided in the construction of new institutions.

In regard to German asylums, the first institution visited was Herzberge, near Berlin (Medical Director, Dr. Moëli), and the Author found in the main block of this asylum there was

accommodation for 800 cases, and that 200 were resident in cottage homes on the estate. The nurses were in the proportion of one to eight, and in the most acute cases one to five. This institution was opened in 1893; the estate has an area of 340 acres.

The Author was much struck with the fact that the single rooms for patients were in many cases double the size of those allowed by the English Commissioners in Lunacy. The windows were lofty, glazed with large sized lights, and 75 per cent. provided with no sort of guard or protection against attempts at suicide; the remainder were provided with light elegant iron trellis. The asylum generally appeared bright and cheerful, but the interior certainly lacked furniture and all the accessories that tend to make these unhappy homes comfortable. The single and strong rooms were lighted by electric arrangements and were unusually capacious and lofty. The Author was much impressed with the advantage of increased medical skill in these institutions, considering the recovery rate of the patients.

Journeying on to Leipzig, the asylum, situate about 12 miles from this city, known as Alt Scherbitz Asylum (an asylum which has been so much referred to by lunacy experts —Medical Director, Dr. Paetz) was next visited. The Author found the accommodation at this institution was for 900 cases (first, second and third class): that the attendants were in the proportion of one to ten; for bed-ridden cases one to five; and there were six medical officers, including the chief. The ratio of medical and nursing staff to patients was identical with that of Herzberge.

This asylum provides for the wants of the Province of Saxony, and is a State institution, commenced in 1876 and completed in 1891.

There is a considerable proportion of private patients in this asylum.

This institution appeared as being most difficult to manage; for instance, the estate is severed by a public road; on the one side of such road part of the administrative block is built, surrounded by detached wards and residences, whilst the kitchens, laundry and other residences are situated on the lower side of the road. All food supplies, cooked and uncooked, have to be carted across in air-tight vans to the

various blocks of buildings; and considering the distance such vans have to travel, it is very questionable what the state of the food would be when it arrived at its destination.

As regards sanitary arrangements, there are no w.c.'s about the building; the dry-tub principle being in use, the same being removed daily on to the land.

The nurses and attendants have no separate sleeping accommodation or rooms, and no recreation room is provided for their private wants.

With regard to Alt Scherbitz, it is difficult to report otherwise than in terms of disappointment. Situated in a lovely locality, with every advantage that could be derived from natural features and luxuriant vegetation, the idea of a separate villa for the mentally afflicted of different classes has been developed to the fullest extent. When, however, examined in detail it completely fails to approach the standard adopted by modern views. Apart from the difficulties of administration introduced by the widely scattered residences, the Author was struck by the extremely comfortless aspect of many of these villas; the excessive plainness, approaching severity, of their rooms: the scanty furniture, and especially the indifferent attempts to improve the comforts and cheerfulness of the better paying patients. The almost entire absence of plants in the rooms was notable, and a few plain prints were the only attempts at mural decoration. Counter to all precedent in English asylum life, as many as *ten* patients were locked in seclusion on the occasion of my visit, indicating only too forcibly that charming natural surroundings and villa residences are *not* potent factors in securing the absence of noisy excitement if other conditions be neglected. There were only ten single rooms throughont the building, and no padded room exists.

All the staircases are of wood, and the ventilation extremely stuffy and bad; whilst in the sewing workroom fifty patients were working, there being only a superficial area of 21 feet per patient. There were no means of isolating infectious cases; if an infectious case did occur it was placed in a single room adjacent to the infirmary ward.

The next asylum visited was at Dalldorf.

The asylum at Dalldorf may perhaps be taken as a type of the Berlin institutions for the insane. Ten separate pavilions —five for men and five for women—are so disposed as to enclose

spacious ornamental grounds for patients' exercise. The classification alike for both sexes was as follows :—

Pavilion for	100 quiet and convalescing cases.
"	100 melancholic and depressed.
"	160 sick, invalid and paralytic (infirmary).
"	50 acute excited.
"	100 epileptics.
	510

Beyond these groups of pavilions was a handsome block for fifty male and fifty female idiots, provided with a spacious gymnasium.

The accommodation afforded by each pavilion was uniformly the same and very simple in character, the corridor-ward being the style utilised. Each block was a single-storied building 330 feet in length, the central portions and ends being alone carried a storey higher. With exception of the infirmary, the first floor is appropriated in all cases as sleeping space—the ground floor being occupied as day-room, dining-room, and observation-dormitory space. The long corridor at the back of each block (and facing the ornamental enclosed grounds) runs the whole length of the building, interrupted only by doorways centrally situated, and lies parallel to the series of day, dining, and sleeping rooms which open directly into it. The block for the quieter class has as many as ten day rooms on the ground floor communicating by doorways with each other in uniform sequence along the length of the building—affording thus the opportunity for subdivision of its 100 patients into ten small groups. The day rooms are lofty, over 24 feet square—the mural decoration of the plainest description. The corridors are very lofty, over 13 feet wide, and lighted by numerous windows, the height of which and the large size of their lights being notable features. At each extremity the corridor terminates in an outside staircase, behind and in front of which are grouped all the single and strong rooms of the pavilion.

The capacity of these single-rooms—2000 cubic feet, is greatly in excess of that allotted to single-rooms in English asylums. The proportion of single-rooms to patients is as follows :—

Ground floor	6 single rooms.
" "	4 strong rooms.
First floor	10 single rooms.
Total	20 for 100 patients (1 to 5).

The sleeping space in the storey above is somewhat differently distributed, four long dormitories extending in line along the whole length of building, each room being about double the capacity of the day rooms below. This is quite in accordance with the most rational principles of segregation, since classification for day purposes should be much more elaborate than for night, apart from the question of night observation. With similar forethought none but single rooms are here placed, the strong rooms for any noisy excited case being placed on the ground floor.

The arrangement generally impressed the Author with the following:—

(*a*) The substantial character of the building;
(*b*) The extreme simplicity and uniformity of the rooms;
(*c*) The great facilities for subdivision of residents into groups;
(*d*) The ready egress in case of fire.

Betwixt two such pavilions as have been described, stretched at right angles to them, a smaller block over 180 feet long for the accommodation of fifty acute and excited cases. In architectural features it resembled the other buildings; in essential features it differed only in the more limited capacity of its corridor and greater proportion of rooms for isolation. On either side of its central entrance was a large dining room betwixt two smaller day rooms with which it communicated; whilst the pine-end of the building was fitted up with the usual accompaniments of single and strong rooms. The proportion of the latter was as follows:—

Ground floor..	6 single rooms.
" "	6 strong rooms.
First floor	10 single rooms.
Total	22 to 50 excited cases.

Turning attention to the infirmary accommodation, the Author found two large pavilions, one for 160 males and another for 160 females respectively. In accordance with their function the greater area of these buildings is devoted to dormitory purposes. The day rooms (six in number), which are small oblong rooms communicating with each other by doorways, are entirely limited to the central block on both floors; whilst on either side stretch a linear series of dormitories amounting on both floors to six-

teen in number. The four main dormitories on each floor are separated by intervening, commodious and well-fitted lavatories. From the central block abuts backward the closet and bathroom accommodation, the latter of four baths on each floor, and a series of four single rooms above and below for isolation, two of these being strong rooms. The residence of the assistant medical officer is at one end of this pavilion.

The pavilion for epileptics does not call for particular mention here, beyond indicating the strong feeling prevailing in Germany that the epileptic class should be entirely severed from the rest of the insane community. Later it will be seen that at Biesdorf a large asylum has been built entirely for the wants of this particular class and of imbecile and idiot children.

The cost of building the several large pavilions, administrative, kitchen and boiler house was 137,017*l.* thus:—

	£
Four pavilions, each for 100 of the quieter class ..	53,578
Two „ „ 50 acute excited	17,247
Two „ „ 160 infirm	26,494
Two „ „ 100 epileptics	17,257
Central administrative	14,006
Kitchens, boiler house and water tower	8,435
	£137,017

The Author then proceeded to Biesdorf Asylum, near Berlin, the Medical Director of which is Dr. Hebold, and the second Medical Officer, Dr. Brandtell.

Here was found accommodation in the male block for 750 cases, and in the detached residences (18 in number) about 25 cases in each house, the division of the sexes being about equal, and in charge of from one to three nurses, according to the nature of the cases accommodated. This asylum was erected to meet the wants of Berlin, and was completed in 1894. The buildings are extremely bright, cheerful and nicely arranged, consisting of administrative in the centre with wards on either side, two storeys in height. The detached residences (18 in number) are admirably arranged, presenting more the aspect of a homely suburban residence adjacent to a large town, abutting on roads having footpaths on either side. Such footpaths are planted with trees, the residences being set back from the road in detached garden, and enclosed with fences and hedges.

Midway between the main buildings of the asylum and these

detached residences a large block of baths—baths of every description: needle, douche, swimming and electrical—such being under the care of a special attendant, whilst the Medical Officer has the sole control of the electrical appliances.

The Author was very much surprised and gratified to see such an excellent arrangement, and considers that much good could be done in our English asylums if more attention were paid to this detail.

Both at Biesdorf and Dalldorf the pathological laboratories are admirably arranged, and quite up to modern views. Every possible facility is afforded their medical staff for original research; and that they take advantage of this was sufficiently evidenced in the activity prevailing here, in the material in progress of examination, and in the published writings of the staff in the 'Berliner Zeitschrift' and 'Archives f. Psychiatrie.' No expense had been spared in providing the best instruments for histological research, and the medical library at Dalldorf contained, not only an excellent series of works, but was provided with all the more important and recent serial publications in the German, French Italian, and English tongues bearing upon the scientific aspects of insanity. The librarian was one of the assistant medical officers, and was held responsible for the care, receipt and issue of books and periodicals. This necessary provision for the staff should strongly recommend itself to the committees of English asylums.

Another feature of great importance at Dalldorf was the provision of a spacious room at the extremity of each block for the reception of a recent case upon admission, and fitted-up in every way for a full clinical examination of the patient during the taking of the case record by the medical officer: the want of such a room is greatly felt in most asylums. Such a room has been provided by the Author in the wards of the recently erected Acute Hospital at the Wakefield Asylum.

On another portion of this estate were residences for 87 idiot children from 6 to 17 years of age, fitted up with day room, school rooms for three classes, gymnasium, dining room, dormitory, and other usual offices. The Author saw the children going to bed, and for the first time recognised the utility of the "box-bedstead" in asylum life. It was very pleasing to see that such care and forethought was being administered to the wants of those poor little helpless ones.

It appears highly desirable that a gymnasium should be placed at the disposal of every asylum, not alone for the idiot and imbecile class, for whom it is of course a most valuable auxiliary in treatment, but also for the asylum community at large.

At the three large State asylums for Berlin, viz. Herzberge, Dalldorf and Biesdorf, the idea of segregation into isolated groups of the different forms of insanity has been a leading principle of construction. The large detached pavilions, without even a connecting corridor, indicate how very essential this principle has been considered; the extra work thus devolving upon the staff being wholly subordinate to the general welfare of patients, or met by an increased ratio of the medical staff to the inmates. In this respect Dalldorf and Biesdorf, perhaps, rank first, since at Herzberge the separate blocks were arranged in somewhat monotonous file behind one another rather suggestive of barrack buildings, whilst at Dalldorf, in spite of the rectangular disposition of the pavilions, the effect was exceedingly pleasing, and at Biesdorf the groupings were distinctively picturesque, with due regard to efficiency.

The ratio of medical and nursing staff to patients may be thus given:—

	No. of Inmates.	Medical Staff.	Nursing Staff.
Dalldorf ..	1300 ..	11 (1 to 118) ..	1 to 10
Herzberge ..	1050 ..	7 (1 to 150) ..	1 to 8 average 1 to 5 maximum
Biesdorf ..	750 ..	5 (1 to 150) ..	1 to 12 minimum 1 to 8 maximum

In respect to medical staff, therefore, these large asylums are far better officered than the majority of English asylums, and this is, of course, accounted for by the segregation of patients in distinct pavilions, and by the impression strongly entertained in Germany that more individualistic treatment should be obtained. On the other hand, the nursing staff, it will be seen, are about in the proportion existing in our English asylums for a mixed class of patients, and are, therefore, under the conditions existing at Berlin, regarded as distinctly inadequate, especially for the acute, excited and recent admissions, except at Herzberge, where the maximum reaches 1 to 5. In other particulars the nursing arrangements were not considered satisfactory—the quality of the nurse was admittedly not up to the British standard; their

efficiency is much reduced by the practice adopted there of insisting upon a large proportion of the staff sleeping in association with the patients; in no asylum did the Author see special provision for the sleeping of nurses at a residence away from the wards. At Herzberge there are 1000 admissions per annum, chiefly from the large Charité, or old Medical Clinic of Berlin; and the discharge given at 80 per cent. naturally caused much surprise. It appears, however, that a large proportion admitted are discharged within a very short period to certain homes existing at Berlin, and receive the supervision of an After-care Association in that city. This provision permits of a more active movement in the asylum community.

The method adopted at these asylums of using venetian blinds for the purpose of darkening the single rooms was distinctly good. At more than one institution the single rooms had double sashes and the spaces intervening between the two sashes utilised for such blind. These blinds could be lowered, raised, or darkened by means of a mechanical arrangement placed in the recess of the wall on the inside of the room. At one asylum an arrangement existed by which the blinds could be lowered on the external front of the window of the single room, and by means of a lever could be so extended outwardly as to form an ordinary sunblind.

Generally speaking the plans and arrangements of these German asylums are much upon one principle—the placing of dormitories for the sick between the day rooms, confining patients to their beds for several days after admission, and individualising the medical treatment and nursing surveillance to a much greater extent than is done in England.

The Author regrets to say that sufficient regard is not paid to the wants and private feelings of the nurses, who as a rule have no separate room to repair to in privacy, and who sleep in the same ward with their patients.

As regards sanitary arrangements, the Author is of opinion that nothing of a very new or improved order of things exists. Soil pipes are found inside the buildings and are not properly ventilated. Closets abut against inner walls, and no system o. sanitary science and disconnection is regarded.

To summarise some of the more important conclusions at which the Author arrived, the value of—(*a*) spacious corridors; (*b*) ample cubic space for those who are confined to single and

strong rooms; (c) the separate pavilion system associated with detached villa residences; (d) the subdivision of each block for purposes of more complete classification; (e) the large infirmary provision; (f) the lofty windows with large lights; (g) the electric lighting; (h) medical baths and electro-therapeutic appliances; (i) gymnasium; (k) large ratio of medical staff to inmates; (l) complete telephonic communication (Biesdorf); (m) elaborate provision for scientific research in pathological museum and laboratories; (n) medical library; and (o) room for clinical examination in each separate pavilion —was especially noted.

On the other hand, the importance of (a) separate residence for the nursing staff, or, at all events, separate sleeping room; (b) a larger ratio of the nursing staff especially for the wants of an acute hospital; (c) a generous floral and artistic decoration of these homes; (d) the highest possible perfection in sanitary appliances; (e) a free supply of padded, strong and single rooms; (f) cubicles in observation dormitories—was impressed by their very absence in the German asylums.

Among the several recently erected important county pauper lunatic asylums in England and Scotland, some occupied and some in course of erection, the following are worth a visit:— Cane Hill Asylum, Surrey; Chichester Asylum, West Sussex; Claybury Asylum and Bexley Heath Asylum, London County Council; Hill End Asylum, St. Albans, for Hertfordshire County Council; Menston Asylum, and Acute Hospital; Wakefield Asylum, for the West Riding County Council; also the annexe buildings of the Dorchester Asylum; Gartloch Asylum, for the Glasgow District Lunacy Board; Hawkhead Asylum, Paisley, Govan District Lunacy Board; Morningside Asylum, Edinburgh.

Cane Hill Asylum was the work of the late Mr. C. H. Howell, at one time Consulting Architect to the Commissioners in Lunacy. Claybury, Bexley Heath, Hill End Asylums, and the annexe buildings of the Dorchester Asylum are the works of Mr. G. T. Hine, the present Consulting Architect to the Lunacy Commissioners. Menston Asylum and the Acute Hospital, Wakefield, in connection with the Wakefield Asylum, is the work of the Author, in addition to which he has other Asylums in hand. Claybury Asylum and the annexe building of the Dorchester Asylum reflect great credit upon their designer. Menston Asylum was, in the Author's opinion, the pioneer in this country

in setting forth the noble example of making these asylums for the poor unfortunate insane, bright, cheerful and heathful, and he believes it has had a great influence upon county authorities in inducing them to break away from the old traditional work-house stereotyped class of buildings which one regrets to say existed to such a great extent in this country.

Of private asylums, which are quite a new feature of County Council work, the building now being erected by the West Riding Authorities and approaching completion at Scalebor Park will well repay the trouble of a visit; whilst the Craig House at Morningside, in connection with Dr. Clouston's Asylum, is certainly worth viewing.

Of Scotch Asylums one cannot speak too highly. It may certainly be urged, and it is to some extent true, that more latitude is permitted by the Scotch Commissioners than the English Board to those having the erection of such buildings, but as to whether this is advantageous is a matter of great doubt.

Gartloch Asylum is situate on the Gartloch Estate, near Garnkirk, about six miles from Glasgow. The extent of the estate is 334 acres. It is served by the Caledonian Railway Company, and has a railway siding midway between Garnkirk and Gartcosh stations. Messrs. Thompson and Sandilands, of Glasgow, are the architects.

The style of architecture, which is a very elaborate and ornate one, is known as the François Premier period. The building is faced with red stone outside from the quarries of Locharbriggs. This institution consists of an asylum proper, with its administrative in the centre and wards facing south, east and west, attached by a longitudinal corridor. The number of patients accommodated is 540. Immediately to the north of these buildings is situate the infirmary or hospital. These buildings were opened on November 10, 1896, and the reception of patients took place on November 18 of that year; the total cost of this asylum was 260,000*l.* The Author was informed that the whole of the nursing of the hospital wards of the male side was performed very satisfactorily by female nurses. He also observed that there were no airing courts merely gardens, and they are not railed or fenced off, except by a continuous bar iron hurdle fence. To the north of the estate, adjacent to the farm, exists a loch as large as one of the

smallest lakes in the English Lake District, not enclosed or fenced in at all, and it was stated by Dr. Oswald that the proximity of this lake caused them no trouble whatever.

The buildings consist of the main asylum and the hospital section. They occupy an elevated site, and, when looked at from the west, have a graceful and handsome appearance. The front block of the main asylum consists of the administrative department, behind which are the stores, kitchen, dining and amusement halls. Four blocks, two on each side of the central section, contain the day room and dormitory accommodation for the patients; the two on the north side are for males and the two on the south for females. The blocks, which are of three storeys, are connected by wide corridors with each other and adjoin the corridor on each side, and a boot-room is attached to each block. The four blocks of the main asylum are capable of accommodating 400 patients, and the hospital section has beds for 140 patients. The whole asylum has, however, accommodation for 540. The number of pauper lunatics chargeable on January 1, 1897, to the City of Glasgow parish was 553, of whom 475 were in asylums and 68 boarded in private dwellings.

The asylum is lighted throughout by electricity generated on the establishment, and the Author understands that the wards are abundantly lighted of an evening. Movable electric lamps are provided for examination of patients during the night.

The Commissioner in Lunacy on his visit on May 3, 1897, speaks of this Institution as follows:—

> "The general impression produced by the visit was that the asylum is admirably suited for the purpose for which it has been built, that its administration, so far, has been organised by Dr. Oswald in a very able and efficient manner, and that the condition both of the patients and of the house was most creditable to Dr. Oswald and his staff."

Among the special features of the hospital which deserved notice are the arrangements for the admission of patients. There are rooms near the entrance of the building, one for men and one for women, furnished as medical consulting rooms, where each of the patients on arrival at the institution is received by a medical officer, and where every convenience is provided for taking notes of such information as can be furnished by those